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Environmental Training Modules Module 9 - Hazardous Waste Operator Training

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
National Steel and Shipbuilding Company
San Diego, California

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ENVIRONMENTAL TRAINING MODULES

MODULE 9

HAZARDOUS WASTE OPERATOR TRAINING

Prepared by:

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May 1999

NSRP 0549
(N1-94-02)

TRAINING MODULES OVERVIEW

Executive Summary and User s Guide (NSRP 0540) Gives an overview of the 10 module set of environmental training modules, plus key issues involved in training in general. Instructions are supplied for how the modules can be modified to suit individual shipyards, as well as hardware and software requirements.

Module 1 (NSRP 0541) Good Environmental Practices

Content: Craft/trade-specific training on items that workers must deal with on a regular basis – material handling, labeling, waste generation/minimization, requirements awareness.

Recipients: New employees on arrival, and existing workers as a refresher.

Module 2 (NSRP 0542) Environmental Practices for Specific Craft/Trade Groups

Content: Specific training on air, hazardous materials, waste minimization, and related environmental considerations, with a focus on the generator personnel and their individual practices and procedures. Emphasis on those personnel likely to encounter a high incidence of problems during their regular duties.

Recipients: Specific craft/trade groups of workers.

Module 3 (NSRP 0543) Shipyard Incident Response Training

Content: Detailed presentation of response requirements specified by OSHA. Basic ingredients of a viable program for a shipyard – what is required and how to reach a satisfactory state of readiness. Includes specific duties of all participants, as well as how to ensure coordination and a common focus. This Module will provide the shipyards with an in-house capability for conducting this important training.

Recipients: Environmental Manager, Environmental Staff Personnel, Safety Engineer, Safety Personnel, Fire Department Personnel, Laboratory Staff and Technicians, Emergency Response Coordinator, Medical Personnel.

Module 4 (NSRP 0544) Shipyard Oil Pollution Prevention and PIC Training

Content: Provides a detailed overview on the federal regulatory oil pollution prevention and response requirements. Also contains specific training material for those shipyard employees with designated “Person in Charge” responsibilities.

Recipients: Ship and Craft Managers and Leadmen, Environmental and Safety Department Personnel, designated Persons in Charge.

Module 5 (NSRP 0545) General Environmental Awareness

Content: Overview of environmental statutes and regulations affecting shipyards, including responsibilities for compliance including both civil and criminal penalties for non-compliance. Includes an overview and explanation of environmental processes - how laws are formulated, the role of environmental groups, consultants, advisers.

Recipients: Senior Management

Module 6 (NSRP 0546) Technical Overview of Environmental Statutes and Regulations

Content: A general but in-depth overview of all environmental statutes and regulations with a focus on shipyard interests, and emphasis on the technical aspects of the requirements.

Recipients: Environmental Managers and staff personnel.

Module 7 (NSRP 0547) Environmental Requirements of Concern to Shipyards

Content: General overview of ALL requirements as they apply to shipyards. Emphasis on technical aspects and actions needed for compliance, rather than on the penalties for non-compliance. Includes overall strategy for developing a strong environmental posture.

Recipients: Senior Management, Supervisors, Generator Personnel; all workers who interface with environmental matters.

Module 8 (NSRP 0548) Generation/Treatment/Minimization of Hazardous Waste

Content: Discussion of regulatory requirements and statutes that apply to shipyard hazardous waste activities. Stresses the high points of the laws, and how to satisfy them. Includes overview of training provided to hazardous waste operators.

Recipients: Middle-level Managers

Module 9 (NSRP 0549) Hazardous Waste Operator Training

Content: Detailed training on practices and procedures performed by hazardous waste operators. Includes reclamation techniques, safe handling practices, labeling/markings, inventory control, hazard minimization.

Recipients: Hazardous Waste Operators; helpers and assistants

Module 10 (NSRP 0550) Environmental Training for Subcontractor Personnel

Content: Briefing on environmental requirements and considerations applicable to all Subcontractor Personnel entering a shipyard environment.

Recipients: Subcontractor Personnel; visitors to a shipyard; transient personnel such as delivery agents, auditors, and oversight personnel.

Hazardous Waste Operator Training For Shipyard Personnel

Title:

The Hazardous Waste Problem (An Overview)

Objective of this Training Session:

The purpose of this module is to provide employees with an overview of the potential effects of hazardous waste on people and the environment.

Introduction: Generally speaking, hazardous waste is any form or type of waste that has chemical properties which may be adverse to human or environmental health. These hazards are inherent properties derived from the chemical constituents of the waste material. The mere fact that a material or product, for whatever reason, is no longer useful for its intended purpose (i.e., a waste) is immaterial to its hazardous properties. For example, a solvent that is flammable or toxic maintains these hazardous properties regardless if the solvent is fresh from the drum or has been used to degrease engine parts and must now be disposed. The fact that it is now a waste (that exhibits hazardous chemical properties) merely identifies when it becomes subject to certain federal and state statutory and regulatory requirements that control how hazardous waste will be managed and disposed.

The proper management of hazardous waste derived from shipyard operations and processes is vital to the continued operations of the facility. Severe penalties can result from the improper control and disposal of hazardous waste. Additionally, not knowing or understanding the obligations imposed on shipyard personnel for complying with applicable federal and/or state statutes and regulations does not provide a very substantial defense for violations. From a business perspective, the improper management of hazardous waste will often result in greater costs and long term liability than a properly managed program. As a result of these reasons and more, it is incumbent that shipyard managers, ship superintendents, craft and shop managers, foremen and leadmen, and hazardous waste handlers learn and understand the elements of the hazardous waste regulatory structure and shipyard management program.

What Makes Waste Hazardous?

There are many inherent hazards that chemicals in waste material can exhibit. These can include both physical hazards such as fire and explosions, and well as human and environmental health hazards. Some common chemical hazards and scenarios are given below:

Safety and immediate (acute) health effects of hazardous wastes:

- Chemical burns to skin or eyes - example: a worker gets sulfuric acid in her eyes and suffers serious injury.
- Inhalation of harmful fumes or dusts - example: inhalation of degreaser solution (e.g., a chlorinated solvent) makes a worker dizzy and nauseous.
- Fires and explosions - example: an oxidizer (e.g., sodium hypochlorite) contacts a flammable organic (e.g., acetone) and a warehouse erupts into flames.

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Long term (chronic) health effects of hazardous wastes:

- Chronic illness - example: a lead worker eats his lunch every day without washing his hands and develops symptoms of lead poisoning after several years.
- Latent chronic illness (delayed) - example: a worker is exposed to a toxic plating solution, retires from the shipyard and develops liver problems two years later.
- Cancer - example: a worker is exposed repeatedly to a fire retardant hydraulic fluid known to cause cancer and develops skin cancer on his arm.

Environmental effects of hazardous wastes:

- Air pollution - example: solvents evaporate from hazardous waste drums with open bung holes.
- Soil contamination - example: a heavy metal plating solution leaks from a rusty drum which was abandoned by the generator and contaminates the soil.
- Ground water contamination - example: paint solvents leak from an old storage tank, seep deep into the ground, and contaminate ground water.
- Drinking water contamination - example: leachate from an old dump site contaminates a private well on adjacent property.
- Contamination of lakes, rivers and oceans - example: antifoulant paint chips containing heavy metals blow off of a floating dry-dock and into a river.
- Accumulation in plants and animals - example: a careless worker dumps hazardous waste in the storm drain. Fish near the storm drain outfall float up to the surface and are consumed by a hungry seagull.

In addition to safety and health risks that can be inherent chemical properties of hazardous waste, there are societal risks associated with the improper management of hazardous wastes. The general public expects and demands that hazardous materials and waste be managed in compliance with the law, and in such a manner as to reduce or eliminate the potential impact on human health and the environment. Some common societal risks and scenarios are given below:

Legal liabilities pertaining to hazardous materials/waste:

- Fines to the shipyard - example: a generator of hazardous waste generates some waste material. He doesn't realize that the waste is hazardous, and discards the material in a trash box without consulting his shop's hazardous waste coordinator. When the waste arrives at the local solid waste landfill, an observant operator suspects that the waste material might be hazardous. The landfill contacts the state hazardous waste agency, and the shipyard is fined for improper disposal of hazardous waste.

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- Criminal charges against the worker, including personal fines and jail sentences - example: an inspector knowingly falsifies information on a hazardous waste manifest. During transportation of the waste, a serious accident occurs, resulting in release of the hazardous waste. A subsequent investigation of the accident reveals the false entries on the manifest. The inspector faces criminal charges and could serve up to fifteen years of imprisonment.

Business issues:

- Cost avoidance - example: a worker mixes a drum of waste chlorinated solvent into a barge loaded with used oil. Instead of reclaiming or selling the oil, the shipyard must now pay to dispose of thousands of gallons of hazardous waste.
- Damage to public image - example: an article in the local newspaper accuses the shipyard of improper hazardous waste management practices due to several minor incidents which have occurred over the last six months. Even if the accusations are unfounded, the article influences the public's perception of the shipyard.
- Internal audit findings - example: during a recent audit by a third party auditor, several drums were found which had been in a ninety-day storage area for more than ninety days. This finding raised serious questions about the shipyard's system for tracking its hazardous wastes prior to manifesting, and indicated potential long term liability for poorly managed hazardous waste disposed of in previous years.
- Debarment - A small amount of hazardous waste is disposed of in a waste bin by a shipyard subcontractor and is discovered later in the day by a state inspector. The shipyard is given a violation for improper disposal. In an effort to settle the violation, the shipyard later pleads guilty to a misdemeanor charge of illegal disposal of hazardous waste. Two months later, the shipyard is notified by government contracting officers that it has been placed on the list of debarred contractors and is no longer allowed to bid or receive government contracts.

The above examples are given to illustrate how hazardous waste can be hazardous to the health of people, the environment and the shipyard. The key to avoiding such problems is to understand the requirements and implement a comprehensive hazardous waste management program.

Statutory and Regulatory Framework for Managing Hazardous Waste: The Resource Conservation and Recovery Act (and its subsequent amendments) is the primary federal statute controlling the generation, storage, transportation and disposal of hazardous waste. RCRA established many important aspects of hazardous waste management, such as generator “cradle to grave” responsibility and tracking of the hazardous waste from generator to transporter to disposal facility. The requirements of RCRA are implemented through regulations promulgated by the Environmental Protection Agency and other federal agencies, such as the Department of Transportation.

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The requirements imposed by RCRA and its implementing regulations will be different depending on what role a person or facility is playing in managing hazardous wastes. These include:

- Generator
- Transporter
- Treatment, Storage, Disposal Facility

The shipyard is subject to the requirements of a generator of hazardous waste. As a generator, the shipyard must comply with and perform the following obligations,:

- Determine whether or not a waste is identified or listed as hazardous in 40 CFR Part 261, "Identification and Listing of Hazardous Waste."
- Obtain an EPA identification number and, if needed, a state identification number.
- Properly store the hazardous waste on-site prior to its transportation to a permitted Treatment, Storage and Disposal Facility ("TSDF"). A large-quantity generator may not store hazardous waste on-site longer than 90 days without a permit.
- Comply with the EPA's container management standards if waste is stored on-site in containers.
- Comply with the EPA's tank management standards if waste is stored on-site in tanks.
- Properly prepare and package the waste for shipment. This includes packaging the waste in DOT-approved containers, and labeling and marking them consistent with DOT requirements.
- Properly manifest the waste using a Uniform Hazardous Waste Manifest form. The manifest must designate the facility to which the waste is being shipped, the transporter, and all identification numbers. (An exception report must be submitted whenever a signed manifest is not returned from a destination within 45 days.)
- Prepare a contingency plan to ensure that operation and maintenance of hazardous waste equipment meet expectations, and a testing program to ensure that required safety and alarm systems are working.
- Keep up-to-date records on your wastes, training programs, safety procedures, manifests, and other key activities.
- Submit a biennial report (EPA form 8700-13A) that covers hazardous waste activity for the previous calendar year. The report must include what and how much waste was generated, who transported it, and where it went.

The regulatory requirements summarized above are for "Large Quantity" generators of hazardous waste. A large quantity generator is a facility that generates 1,000 kilograms (2,200 lbs) or more per month. The federal hazardous waste regulations also recognize other smaller categories of hazardous waste generators for which the regulatory requirements are not as comprehensive. These categories include "Small Quantity" generators (more 100 but less than 1000 kilograms per month), and "Conditionally

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Exempt Small Quantity” generators (no more than 100 kilograms per month). Almost all shipyards, except for very small companies, will be large quantity generators of hazardous waste.

Training Requirements for Hazardous Waste Personnel: Federal hazardous waste management regulations require appropriate training for all personnel that work with hazardous waste. This training is required to ensure that hazardous waste personnel know how to properly do their job, respond to emergencies, and protect themselves from chemical hazards. For large quantity generators of hazardous waste, the following training requirements apply:

- Hazardous waste personnel must successfully complete any requisite training program(s) within six months after the date of their employment, and/or assignment to the hazardous waste handling facility (or duties) and/or assignment to a new position at the hazardous waste management facility.
- Hazardous waste personnel must not work in an unsupervised position until they have completed the training requirements.
- Hazardous waste personnel must take part in an annual review of the initial training requirements.

The federal regulations provide for both general and specific subject areas of training that hazardous waste personnel must receive. These subject areas include:

- General - Instruction or on-the-job training that teaches personnel to perform their duties in a way that ensures the facility’s compliance with applicable sections of 40 CFR 265; *Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*.
- Specific - Instruction or on-the-job training that teaches personnel to respond effectively to emergencies involving the management of hazardous waste.

These include:

1. Procedures for using, inspecting, repairing, and replacing emergency equipment;
2. key parameters for automatic waste feed cut-off systems;
3. communications or alarm systems;
4. response to fires or explosions;
5. response to ground water contamination incidents; and
6. shutdown of operations.

Finally, the training program must be directed by a person trained in hazardous waste management procedures, and must include instruction which teaches facility hazardous waste management procedures (including contingency plan implementation) relevant to the positions in which the personnel are employed.

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Proper training is the first step to both ensuring compliance with the hazardous waste regulations, as well as facility and worker safety. Training for the proper management of hazardous waste is no different than training for any other production craft. Once a worker becomes skilled, he or she will be capable of doing their jobs with greater efficiency and safety.

Hazardous Waste Operator Training For Shipyard Personnel

Title:

Standards Applicable to Generators of Hazardous Waste

Objective of this Training Session:

To provide a understanding of the federal regulatory requirements for generators of hazardous waste.

Introduction: The federal regulatory standards for generators of hazardous waste are codified at 40 CFR 262. This Part of the Code of Federal Regulations contains several Subparts as follows:

- Subpart A - General
- Subpart B - The Manifest
- Subpart C - Pre-Transport Requirements
- Subpart D - Recordkeeping and Reporting
- Subpart E - Exports of Hazardous Waste
- Subpart F - Imports of Hazardous Waste
- Subpart G - Farmers
- Subpart H - Transfrontier shipments of hazardous waste for recovery within the OECD

For most shipyards, only Subparts A, B, C, and D will be applicable in their normal operations. For this reason, the specific details for Subparts E, F, G, and H will not be provided in this training session.

Subpart A - General: This Subpart provides for several general requirements:

- defines the purpose, scope and applicability of the regulations to generators of hazardous waste;
- requires a generator of solid wastes to determine if the waste is a hazardous waste; and,
- requires an EPA Identification Number prior to treatment, storage or disposal of hazardous waste.

Subpart B - The Manifest: This Subpart defines the requirements for the use of the Uniform Hazardous Manifest for the transport of hazardous waste. It includes:

- general requirements for using manifests;
- acquisition of manifests;
- the number of manifest copies required and to whom the copies are supplied; and
- specific direction on the use of the manifest.

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Subpart C - Pre-Transport Requirements: Before transporting hazardous waste, or offering waste for transport, a generator must meet specific pre-transportation requirements. These include:

- packaging the waste in accordance with Department of Transportation regulations on packaging (49 CFR parts 173, 178, and 179);
- labeling the package in accordance with Department of Transportation regulations (49 CFR part 172);
- marking each package in accordance with Department of Transportation regulations (49 CFR part 179), and for each container of 110 gallons or less the following words and information:

HAZARDOUS WASTE-Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.

Generator's Name and Address: _____

Manifest Document Number: _____

- placard transport vehicle, or offer the initial transporter the appropriate placards, according to Department of Transportation regulations (49 CFR 172 Subpart F);
- accumulation of hazardous waste on-site for a period of no longer than 90 days, without a permit or without having interim status. Furthermore, on-site waste storage must comply with EPA on-site management standards for containers, tanks, drip pans, containment buildings, and waste container marking and labeling requirements.

Subpart D - Recordkeeping and Reporting: The hazardous waste regulations require that a generator keep specific records regarding hazardous waste activities, and also prepare and file reports regarding these activities. These include the following:

- on-site recordkeeping of manifests, Biennial and Exception Reports, test results, waste analysis and other documentation regarding waste determinations;
- file a Biennial Report of hazardous waste activity by March 1 of each even number year (EPA Form 8700-13A);
- file an Exception Report if the generator does not receive a copy of the manifest with the handwritten signature of the owner or operator of the designated facility within 35 days of the date the waste was accepted by the initial transporter;
- provide any additional report that the EPA may require concerning the quantities and disposition of hazardous wastes.

Summary: The above requirements as contained in 40 CFR 262 Subparts A, B, C, and D establish the basic standards for generators of hazardous waste. The consistent and correct execution of these requirements is essential to maintaining compliance with the federal regulations. This information is important not only to hazardous waste personnel, but also to shipyard craft and shop managers, ship superintendents, and others whose activities result in the generation of

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hazardous waste. When facility personnel have the knowledge and understanding of how the requirements are implemented at the point of generation, greater efficiency of operation can be achieved.

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Title:

Other Regulatory Requirements for Generators of Hazardous Waste

Objective of this Training Session:

To gain an understanding of additional regulatory requirements that a facility may be subject to concerning the management of hazardous waste.

Introduction: 40 CFR 262 - *Standards Applicable to Generators of Hazardous Waste* - contains the specific federal requirements for hazardous waste generators. Additionally, Subpart 262.34 - *Accumulation Time* - provides for other hazardous waste generator requirements if the waste is stored on site for less than 90 days, and is managed in such a way so as to comply with certain specific Subparts of 40 CFR 265 - (*Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*). The specific Subparts of Part 265 that are applicable to all generators that store hazardous waste on-site on for 90 days or less are:

- Subpart C - *Preparedness and Prevention*; and
- Subpart D - *Contingency Plan and Emergency Procedures*.

Additionally, hazardous waste must be stored on-site using containers, tanks, drip pads and/or containment buildings. Depending on which of these is used, one or more of the following subparts will be applicable:

- Subpart I - *Use and Management of Containers*
- Tanks, Subpart J - *Tank Systems*;
- Subpart W - *Drip Pads*; and
- Subpart DD - *Containment Buildings*.

Finally, if waste is stored in containers or tanks, the following sections of Part 265 is applicable:

- Subpart CC - *Air Emission Standards for Tanks, Surface Impoundments, and Tanks*.

Where applicable to shipyard operations, each of the above subparts that contain regulatory requirements for generators of hazardous waste will be detailed in the following training session.

Subpart C - Preparedness and Prevention: This Subpart requires that facilities be maintained and operated to minimize the possibility of an accident or emergency involving hazardous waste. Specific requirements include:

- Equipment for internal communications for emergency notification and instructions, external communication equipment to notify and request assistance from off-site emergency responders, fire suppression and spill control and clean-up equipment, and water to supply water hose systems.

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- All facility communications or alarm systems, fire protection equipment, spill control equipment, and decontamination equipment, where required, must be tested and maintained as necessary to assure its proper operation in time of emergency.
- Whenever hazardous waste is being physically managed (poured, spread, pumped, transferred, etc.), all personnel involved in the operation must have immediate access to an internal alarm or emergency communication device. If even just one employee is on the premises while the facility is operating, that person must have immediate access to a communication device capable of summoning external emergency assistance.
- The facility must maintain aisle space to allow unobstructed movement of personnel, fire protection equipment, spill control equipment and decontamination equipment to any area of the facility operation in an emergency.
- The facility must attempt to make arrangements with local and state emergency response organizations (police, fire and emergency response teams) as appropriate for the type(s) of hazardous waste handled, to familiarize them as to the facility layout and operations. Where state or local authorities decline to enter into such arrangements, the facility must document the refusal in its operating record.

Subpart D - Contingency Plan and Emergency Procedures: This Subpart requires the preparation of a detailed plan that addresses the various possible emergencies that may occur during the on-site management of hazardous wastes, and the procedures that should be implemented when an emergency does occur. Specific requirements include:

- The requirement for each facility to have a contingency plan that is designed to minimize hazards to human health or the environment from fires, explosions or any unplanned sudden or non-sudden release of hazardous wastes to air, soil or surface water. The provisions of the plan must be carried out whenever there is a threat to human or environmental health caused by a fire, explosion or release.
- The requirement for the content of the plan to describe the actions that facility personnel should take in response to fires, explosions or releases of hazardous waste. The plan must also contain a description of arrangements agreed to by local and state emergency response organizations, the identification of the facility emergency coordinators and their office and home phone numbers and an up to date list of all emergency equipment at the facility. Finally, the plan must include an evacuation plan for facility personnel in the event an evacuation is necessary.
- Copies of the contingency plan and all revisions must be kept at the facility and submitted to all local emergency response organizations that may be called upon to provide emergency services.
- The contingency plan must be reviewed and amended based on changes to applicable regulations, facility design, construction or operation, changes in emergency coordinators and/or changes in emergency equipment.

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- The requirement that there must be at least one employee on-site or on-call at all times, with the responsibility for coordinating emergency response measures.
- The requirement that whenever there is an imminent or actual emergency situation, the emergency coordinator shall activate the facility alarm or communication system, and notify state or local agencies with designated response roles if their help is needed. Additionally, the emergency coordinator must make determinations and assessments regarding the nature of the emergency and its potential impact on and off-site of the facility. During the emergency, the coordinator must take all reasonable measures to ensure fires, explosions and releases do not occur, or recur or spread. Following the emergency, the coordinator must provide for treatment, storage or disposal of recovered waste, and any waste generated as a result of the emergency. Finally, the affected area of the facility must be cleaned up and decontaminated prior to resumption of operations.

Subpart I - Use and Management of Containers: This Subpart requires that facilities which store hazardous waste on-site in containers (such as 55 gallon drums) must use and manage the containers according to the following requirements:

- Containers holding hazardous waste must be maintained in good condition. If the container is not in good condition the waste must be transferred to another container, or managed in some manner that prevents leaks, spills or releases.
- The container, or its liner, must be compatible (non-reactive) with the waste stored in it. Any container holding hazardous waste must not be opened, handled or stored in a manner that may rupture or cause it to leak.
- At least weekly, containers holding hazardous waste must be inspected for leaks and/or deterioration caused by corrosion.
- Reactive or ignitable waste in containers must be located at least 15 meters (50 feet) from the facility property line.
- Incompatible wastes or materials must not be placed in the same container. Containers holding wastes incompatible with other waste stored in nearby containers (or other devices) must be separated from each other by means of a dike, berm, wall, or other device.
- Any facility that stores hazardous waste in containers must comply with the applicable requirements for air emission standards for use of containers to manage hazardous waste.

Subpart J - Tank Systems: The requirements of this subpart apply to facilities that use tank systems to store hazardous waste. The requirements include:

- Existing tank systems without secondary containment must be assessed and certified by a registered engineer, per the requirements of this subpart, to be fit for use.
- The design and installation of new tank systems or components must be such that the requirements of this subpart are met. Additionally, the tank system must be assessed

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and certified by a registered professional engineer, per the requirements of Subpart 265.192.

- Secondary containment must be provided for existing tanks within a phased time schedule, and for new tanks prior to being put into service. The secondary containment systems must meet the standards established in Subpart 265.193.
- Hazardous waste must not be placed in a tank system if it could cause the tank, its ancillary equipment or secondary containment system to rupture, leak, corrode or otherwise fail.
- The facility must inspect various elements (as specified in Subpart 265.195) of the tank system on a daily basis. The inspection results must be entered into the operating record of the facility.
- When a tank system is closed, it must be decontaminated of all waste residues, contaminated soils and other residuals, which must be managed as hazardous waste.
- Ignitable or reactive waste must not be placed in a tank system, unless the waste is treated, rendered, or mixed before or immediately after placement, such that the resulting waste material is not ignitable or reactive.
- Incompatible wastes must not be placed in the same tank system.
- Any facility that stores hazardous waste in tank systems must comply with the applicable requirements for air emission standards for use of tank systems to manage hazardous waste.

Subpart CC - Air Emission Standards for Tanks, Surface Impoundments, and Containers: These requirements apply to facilities that store hazardous waste in tanks, surface impoundments or containers, if the waste has a volatile organic content of 500 ppm (0.05%) or greater. Its purpose is to reduce the amount of volatile organic emissions from hazardous waste during on-site storage and handling. Specific requirements for tanks and containers include:

- Tanks - Depending on the design capacity of the tank and physical properties (vapor pressure) of hazardous waste it will store, the facility must control air pollutant emissions in accordance with either “Tank Level 1” or “Tank Level 2” standards as specified in Subpart 265.1085.
- Containers - Depending on the design capacity of the container, the physical properties of the waste (vapor pressure and percent of organics) and if the container is used for treatment of hazardous waste by a waste stabilization process, either “Container Level 1” or “Container Level 2” or “Container Level 3” standards specified in Subpart 265.1087 will apply. Level 1 air pollution controls for containers (which includes 55 gallon drums) can be met by using DOT approved containers, and keeping the lid or closure closed when not actively adding or removing material.

Hazardous Waste Operator Training For Shipyard Personnel

Title:

Hazardous Waste Safety - Health Hazards

Objective:

To provide a detailed explanation of the potential health hazards that hazardous waste handlers may encounter during the performance of their job. The hazardous waste handlers will be able to protect themselves and other workers from unnecessary risks with an understanding of what these hazards are.

Introduction: The hazards associated with hazardous waste are not unique to “waste,” but are derived from the intrinsic physical and chemical properties of those chemicals that make up the product that has become a waste. For this reason, any discussion of the hazards of hazardous waste are in fact merely reflective of chemical hazards. These hazards may be health hazards such as skin irritation, tissue and/or organ damage, reproductive impairment or disease. Additionally, chemicals can have physical hazards which can effect your health such as flammability and reactivity. This training session provides information on these aspects of chemical hazards that will help you in determining what risks may be present in a hazardous waste. From this determination, proper operational, engineering, and behavioral controls can be applied to reduce any risks to an acceptable level.

Toxic Hazards: Toxicology is the branch of science that studies poisons and their effects. The earliest toxicologists, in their struggle for survival, divided all substances into two categories: foods or poisons. Poisons were those materials that either killed you or made you very sick. Thus, early "toxicology" had no regard for long-term toxicity. Only immediate effects were considered.

Paracelsus (1493-1541), an early physician, was one of the first modern toxicologists who recognized that the quantity of the substance was a critical determinant of toxicity. His understanding of toxicology is defined by: "All substances are poisons, there is none that is not a poison. The right dose differentiates a poison and a remedy."

The first person known to recognize occupational illness was Percival Pott (1775), who observed high rates of scrotal cancer in London's chimney sweeps. The chemical culprit, found much later, was benzo-a-pyrene, belonging to a class called poly-nucleated aromatic hydrocarbons, which is a common product of combustion.

The last 30 to 50 years have exhibited explosive growth in the study of toxicology. Although this field may at first seem narrow, it is actually quite broad. There are many subdivisions, as displayed in the table below:

Type of Toxicology	Focus and Concern
Clinical	Concerned with the effects of chemical (drug) poisoning and the treatment of poisoned people.
Descriptive	Concerned directly with the toxicity-testing of chemicals.

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Environmental	Concerned with the ultimate environmental fate of chemicals and their impact upon the biological ecosystem and human populations.
Forensic	Concerned with applying techniques of analytical chemistry to answer mediological questions about the harmful effects of chemicals.
Industrial	Concerned with the disorders produced in individuals who have been exposed to harmful materials during the course of their employment.
Mechanistic or Biochemical	Concerned with elucidating the biochemical mechanisms by which chemicals exert their toxic effects.
Regulatory	Concerned with assessing descriptive data with regard to the risk involved in the marketing of chemicals, their legal uses, and chemical reporting.

What is Toxic? - It is not always clear what materials are toxic. For example, cyanide salts, commonly found in metal plating shops, are toxic. But, water and oxygen are toxic too. Most would agree that cyanide is very toxic, and the ingestion of small amounts can be fatal. Yet, we regularly ingest water, and we regularly inhale oxygen to survive. How can they be toxic?

A key concept of toxicology is quantity or dose. The quantity of material to which an organism is exposed directly determines its hazard. Water and oxygen in proper amounts are essential to sustain life. Yet, too much oxygen is toxic, resulting in biochemical disturbances and cellular damage. Too much water is also toxic and fatal! Another key to accurate hazard evaluation is the proper comparison between the toxicity of a chemical and the potential risk it poses. Toxicity refers to the ability of a chemical to cause injury once it reaches a susceptible site in, or on, the body. Without considering risk and toxicity, an accurate hazard evaluation is unlikely. It must be understood that it is the toxicity, in conjunction with exposure, that defines the risk to which the hazardous material handler is exposed.

Risk is independent of toxicity, since it refers to the factors that determine the hazards of a material, rather than the intrinsic ability of a chemical to cause harm. The likelihood that a chemical will cause injury, susceptibility of the recipient, length of exposure, concentration and toxicity of the material are all factors which are significant to the hazard of a situation. For example, cyanide salts are highly toxic, although they are not likely to cause widespread exposure problems because they are generally found in solid form and are not airborne and mobile. However, anhydrous ammonia, far less toxic than cyanide salts, may present a greater widespread risk because as a vapor, it is highly mobile.

Exposure may occur through a variety of different media. However, all the exposures may be grouped in terms of the timeframe of exposure, and time delay for the ultimate response.

- **Acute** - single exposure or occurring over a short time period (one day or less).

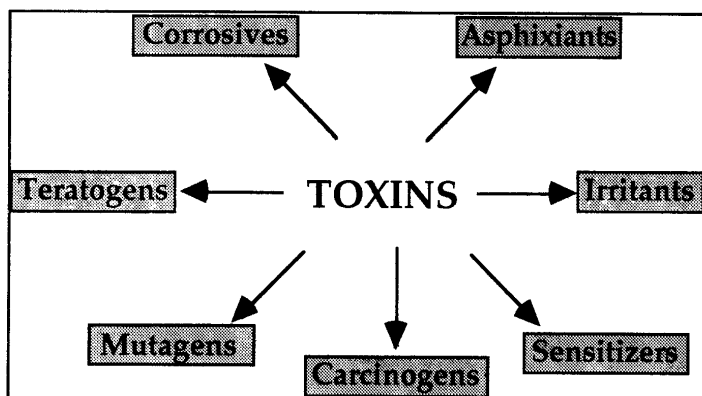
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- **Subchronic** - intermediate exposures between acute and chronic, may be for up to ninety days.
- **Chronic** - multiple or constant exposure to concentrations that do not cause an acute toxic response.

Acute effects occur when one feels symptoms within a short period of time, (within minutes or hours). Examples of acute effects include: headaches, teary eyes, sore throat, dizziness and nausea. In contrast, a chronic effect or illness develops slowly and may last for a long time. Chronic poisoning is usually because of continued exposure to a harmful chemical for months or years. Examples of chronic effects include cancer, sterility, kidney and liver damage.

BE AWARE OF BOTH THE ACUTE AND CHRONIC EFFECTS OF A HAZARDOUS SUBSTANCE.

Hazardous Substance Exposure Health Effects: There are several types of toxic effects that hazardous substances may have on the body when exposure occurs. These are important to understand in an emergency situation. Some, such as acrolein (a common combustion byproduct) are so reactive that simple contact causes cytotoxicity (cellular death). Other toxins, though chemically inert, can fatally displace oxygen. Toxins are divided into several basic types: asphyxiants, corrosives, irritants, sensitizers, carcinogens, mutagens, and teratogens. Remember, however, that materials may fit in more than one category.



Asphyxiants: Asphyxiants are gases that deprive the body tissue of oxygen. There are two types: simple and chemical. A *simple asphyxiant* displaces the oxygen in the breathing air. These are very important to identify in confined spaces, and especially in emergency situations. Examples are carbon dioxide, ethane, helium, hydrogen, methane, argon, and nitrogen. Another type of asphyxiant is a *chemical asphyxiant*. Chemical asphyxiants are gases that actually prevent oxygen use by the cells even though enough oxygen is delivered. Examples are carbon monoxide, hydrogen cyanide, and hydrogen sulfide. At high levels, all asphyxiates can cause a person to collapse, become unconsciousness, and even die.

Simple asphyxiants are hazardous due to the hypoxia caused by oxygen depletion. Environments with oxygen levels less than 19.5% are considered hazardous and are illegal to enter without respiratory protection. A concentration of 7% (70,000 parts per million - ppm) of a simple

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asphyxiant is sufficient to cause hazardous oxygen depletion as displayed in the table below. A rule of thumb is that a given contaminant will deplete the oxygen concentration by one-fifth of the original contaminant concentration. A 10% (100,000 ppm) concentration of contaminant will deplete the oxygen by approximately 2%, which is very dangerous without supplied air.

Approximate Oxygen Levels Based on Contaminant Concentrations

Contaminant Gas (ppm)	Gas (% in air)	Oxygen Reading
10,000	1.0	20.7
20,000	2.0	20.5
30,000	3.0	20.3
40,000	4.0	20.1
50,000	5.0	19.9
60,000	6.0	19.7
70,000	7.0	19.5

Chemical asphyxiants act biochemically on the respiratory system. The toxicity of these compounds is not directly related to oxygen depletion. Consequently, much smaller concentrations of chemical asphyxiants are hazardous, as compared to simple asphyxiates.

There are several sub-groups of chemical asphyxiants based on where and how they affect the respiratory system.

- **Blood asphyxiants** combine with red blood cells and render them incapable of carrying oxygen to the cells in the body. Carbon monoxide, the most common blood asphyxiant, has a 200 times greater affinity for oxyhemoglobin than does oxygen.
- **Tissue asphyxiants** are carried by the red blood cells and deposited in other cells of the body. They render the cell incapable of accepting further oxygen from the red blood cells. Hydrogen cyanide, a common material found in metal plating shops, and a common combustion by-product, functions by interfering with the cells' ability to convert food sugars to a form more readily usable by the cell biochemical process. This eliminates the demand for oxygen, causing suffocation and cell death.
- **Respiratory paralyzer asphyxiants** short circuit the respiratory central nervous system. Hydrogen sulfide (H_2S) attacks the olfactory nerve and paralyzes the nerve that controls the breathing process. Other examples of respiratory paralyzers are carbon disulfide (CS_2), acetylene, ethylene and ethanol.

Irritants: Irritants are toxins that cause temporary (but sometimes severe) inflammation of the eyes, skin or respiratory tract. Some examples of irritants are ammonia (NH_3), hydrogen fluoride (HF), chlorine (Cl_2), and hydrogen chloride (HCl). Irritants can also be corrosive materials which attack the mucous membrane surfaces of the body. These are more than "irritating." They are

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deadly at moderate concentrations. Irritants are divided into two types: respiratory and skin irritants.

Respiratory Irritants	May cause injury to the nose, mouth, throat and lungs. Examples of respiratory irritants that affect both the upper and lower lung are chlorine and ozone. Respiratory tract irritation can be minor, such as a tightening of the chest or bronchitis. But it may also be very serious, as in pulmonary edema, which can cause death.
Skin Irritants	May cause contact dermatitis, redness, itching and drying of the skin. Examples are organic solvents and detergents. Very corrosive agents, such as chromium and nickel, can cause skin ulcers and destroy tissue.

The water-solubility of irritants will affect where they impact the body. Highly water soluble irritants, such as the halogen acid gases, (HF, HCl and Cl₂, HI, SO₂ and NH₃), will readily dissolve in the first moisture they meet; at the eyes, nose and throat. Moderately water soluble irritants are in the upper respiratory tract and lungs. Halogen gases, ozone, phosphorus trichloride and phosphorus pentachloride are examples of moderately water soluble irritants. Slightly water soluble irritants do not readily dissolve in water, and bypass the moist areas (mucous membranes) that the first two groups attack. These materials exert their damage deeper in the lungs by destroying the alveoli, sometimes with delayed effects of up to 12 hours. For example, nitrogen oxides can produce fatal effects, principally pulmonary edema, from 4 to 48 hours after exposure.

Allergenic Sensitizers: After repeated exposures to certain chemicals, some individuals experience an allergic or immune reaction. Allergic sensitizers generally affect the skin and respiratory tract. The symptoms are often the same as those caused by irritants. Symptoms include dermatitis or bronchitis. As with irritants, the response may be very serious, and may even cause death. Examples include: isocyanates, phenol resins, and epoxy resins.

Systemic Toxins (Internal Poisons): Systemic toxins are chemicals that can cause damage to vital organs in the human body. They can damage blood cells, the nervous system, the liver, the kidneys and reproductive cells. The following table provides a description of each type:

Blood System (Hemolytic) Toxins	These toxins damage blood cells or interfere with blood cell formation. Examples include benzene, methylene chloride, arsine, phosphorus, and naphthalene.
Nervous System (Neuro) Toxins	These toxins damage the nervous system. Typical symptoms include dullness, muscle tremor, restlessness, convulsions, loss of memory, epilepsy, and loss of muscle coordination. Examples include mercury, insecticides, hexachlorophene, and lead.
Liver (Hepato) Toxins	These toxins cause liver damage, including jaundice and liver enlargement. Examples include alcohols and carbon tetrachloride.

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Kidney (Nephro) Toxins	These toxins damage the kidneys, causing swelling and increased serum proteins in the urine. Examples include halogenated hydrocarbons and heavy metals.
Reproductive Cell (Gameto) Toxins	These toxins damage the reproductive cells (egg and sperm) or interfere with their formation. Examples include lead, cadmium, cellosolves, and vinyl chloride.

Carcinogens: Cancer is the uncontrolled growth of malignant (harmful) cells at any site in the body. Carcinogens are chemicals that are known to cause cancer in humans or animals. Over 200 substances are known human carcinogens. Many other substances are under study as suspected carcinogens. Carcinogens differ somewhat from other toxins for two important reasons: 1) very small amounts of material can cause a carcinogenic effect; and 2) the effects of exposure may not appear for years. Theoretically, one molecule can cause cancer (called the one-molecule one-hit theory), although cancer is much more likely after substantial, repeated exposures. In general, it is believed that the development and problems caused by cancer may be delayed for 20 to 30 years after exposure. Whenever a known or suspected carcinogen is involved, the hazardous waste handler must use the highest levels of appropriate protection. Some examples of carcinogens are coal, tar, asbestos, vinyl chloride, ethylene dibromide, toluene and benzene.

Teratogens: “Terata” in Greek means “monster.” Teratogens are agents that are known for their ability to cause malformations in an unborn child. Classic forms of fetal malformations are phocomelia (reduced limbs) or amelia (absent limbs). Chemicals are classified as teratogens and reproductive toxins if they affect the ability to conceive, bear, or nurture offspring, and/or influence the function or viability of sperm cells. Teratogens are toxins that cause physical defects in a developing embryo or fetus. Some substances known to be teratogenic in humans are anesthetic gases, organic mercury compounds, and ionizing radiation.

Mutagens: Mutagens are toxins that cause a change (mutation) in human genetic material (DNA and RNA). Mutation of the reproductive cells may cause birth defects in future children. These genetic changes can have numerous effects including the failure of important biochemical processes. Some known human mutagenic toxins are: ethylene oxide, ionizing radiation, hydrogen peroxide, hydrazine, EDB (ethylene dibromide) and benzene. Mutation of other cells in the body may cause cancer or defects in developing embryos or fetuses.

Corrosive Hazards: Corrosives are also defined as those materials causing irreversible damage to living tissue upon skin contact, as determined in laboratory studies. Corrosive materials are capable of destroying metals as well as organic materials (such as skin tissue). Some corrosive materials may also be strong oxidizers such as nitric and perchloric acids. Examples of high pH corrosive materials are sodium hydroxide and potassium hydroxide. Inorganic chlorides such as phosphorus pentachloride, stannic tetrachloride, and thionyl chloride are also corrosives because they yield hydrochloric acid upon hydrolysis.

Biological Hazards: Wastes from hospitals, medical offices, and research laboratories may contain infectious substances that can cause infection or disease in humans. These substances are

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called etiologic agents or regulated medical waste, and may be contained in water and dispersed by the wind. These substances may be in the form of body parts, sharps (needles), bandages and vials containing human blood. Other biologic hazards may be contained in poisonous plants, insects, animals and indigenous pathogens. Hazardous waste site workers must be aware of these types of substances and be capable of identifying them.

Radioactive Hazards: Radiation hazards, although very dangerous, are the least likely to be encountered. There is a much higher probability of exposure to chemical and physical hazards at a hazardous material site or during an emergency response operation at the shipyard. Surprisingly enough, radiation hazards are easily detected, measured and controlled. There are two types of radiation: non-ionizing and ionizing. Non-ionizing radiation is present in daily life from microwave ovens, and radio and television waves.

Reactivity: Reactive materials may cause fires, explosions and may liberate toxic gases during their reaction that are hazardous to human health and the environment. Reactives are dangerous for the hazardous waste handler because they can be unpredictable. In general, reactive substances exhibit one or more of the following characteristics:

- Normally unstable and readily change violently without detonating;
- Reacts violently with water;
- Forms potentially explosive mixtures with water;
- When mixed with water, generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment;
- Cyanide or sulfide bearing waste that, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment;
- Capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement; and
- Readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.

These characteristics generally define highly reactive materials such as explosives, water reactive materials (i.e., sodium, strong acids), or sulfide and cyanide bearing compounds.

Some compounds by themselves are not reactive when mixed with other materials having similar properties, and do not produce dangerous reactions. However, the same compounds, when mixed with materials that are not compatible, will cause an adverse reaction. For example, two mineral acids such as sulfuric and hydrochloric, when mixed, do not adversely react. However, mixing one of the same compounds with methyl ethyl ketone will cause the generation of heat and fire.

When examining possible mixtures of compounds, it is necessary to evaluate the compatibility of the compounds. An incompatible mixture of compounds could produce one or more of the following: heat, polymerization, fire, explosions and gas (toxic and/or flammable). For example,

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spilling an oxidizing material onto clothing, or mixing it with a material such as sawdust, will cause heat and fire.

Some compounds are reactive with water. Calcium carbide, a granular type of material, is a flammable solid and dangerous with a wet substance. If a container is left open on a humid day, moisture from the air will be absorbed and initiate a fire. This reaction will also generate flammable acetylene gas.

Toxicity and Routes of Exposure: The dose makes the poison. This is the basic tenet of toxicology. Since the dose is the amount of substance to which an organism is exposed, a restatement could be **the exposure makes the poison**. Exposure is dependent upon the degree to which a substance, in absorbable form, comes in contact with surfaces of an organism capable of absorbing it.

The concept of exposure routes is very important for the shipyard hazardous waste handler because of their need to recognize a hazardous situation where exposure can be extremely dangerous or even fatal. There are three main routes by which toxins can enter the body: absorption, inhalation and ingestion.

Exposure Route	Absorption Site
1. Inhalation	Lungs by inhalation (breathing in) and absorption through the lung walls into the body
2. Dermal	Skin by direct contact and absorption through the skin into the body (also eyes)
3. Oral	Digestive tract by ingesting (swallowing) substances into the body's digestive tract or gastrointestinal (GI) tract

Note: The route of exposure can result in different rates of absorption and different toxic effects. Exposures can be controlled by using proper personal protective equipment (PPE).

Inhalation Exposure (The Lung Exposure Route)

Inhalation exposure is the most common way that hazardous substances enter the body, especially in an emergency response situation. The lungs are the largest exposed surface area of the body and facilitate the transfer of gases into and out of the body. If your alveoli (the tiny sacs at the bottom of the lungs) were flattened out, they would cover an area the size of a tennis court. This huge surface area is only a single cell thick, which allows a chemical to travel into the bloodstream quickly. The large surface area can result in rapid absorption into the bloodstream.

The most significant factor in the rate of absorption for inhalation is respiration. The rate of absorption can increase substantially if the rate or depth of respiration increases. This has important implications for hazardous waste handlers who are likely to be performing heavy physical work in contaminated environments, and therefore, are breathing faster and deeper.

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Since the lungs serve as an absorption point, they can also be the route of entry into the body for many substances that effect target organs, or systems other than the lungs themselves. An important example of a systemic toxin absorbed through the lungs is carbon monoxide.

The mucous cells within the lining of the nose trap inhaled dirt and other foreign particles, pushing them toward the throat where they are swallowed. Most inhaled foreign particles are delivered to the digestive system in this way. Although the digestive system is less delicate than the lungs, and more capable of disposing of hazardous materials, it still may be severely effected by substances that enter the body through inhalation.

Similarly, potentially hazardous particulate compounds may be deposited in different areas of the lungs depending on the particle size, with the smallest particles penetrating the furthest. Once deposited, particulates in the lungs can have acute or chronic toxic effects.

Factors that may influence the absorption of inhaled toxicants are:

- Specific gravity of the particle
- Particle charge
- Hygroscopicity
- Respiratory frequency
- Respiratory depth
- Local temperature and humidity
- Nature of the aerosol (fineness of dispersion)

Toxic Effects of Inhalation

The responses of the respiratory system to toxic agents may be divided into the following general categories:

- **Irritation of the respiratory tract** results in constriction of airways and may lead to infection and fluid build-up in the lungs. Examples of chemicals that cause irritation are hydrogen chloride and ammonia.
- **Sensitization** can lead to short-term constriction of the airways through an allergic response and may also develop into long-term or chronic pulmonary disease. Examples of sensitizers include isocyanates and sulfur dioxide.
- **Production of fibrosis (scar-like tissue)** may block the air passages, thereby causing decreased lung capacity. Examples of toxins that can cause fibrosis include silica, asbestos and beryllium.
- **Development of lung cancer, and resulting necrosis (cell death).** Examples of toxins causing this result include coke oven emissions, asbestos and arsenic. The lungs are also the entry site for asphyxiants and other toxins.

Dermal Exposure (The Skin Exposure Route):

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The skin is a specialized organ that provides a barrier between the environment and internal organs. The skin is not highly permeable and provides good protection against most compounds. Although a small amount of toxicants can enter through the hair follicles and sweat glands, the majority of chemicals must pass through the densely packed skin cells before entering into the blood stream. Hazardous waste handlers should never assume that the skin provides adequate protection in a situation involving hazardous waste. If the skin is damaged, its protective barrier can break down immediately.

It is important to remember that many forms of chemicals, including solids, liquids, gases and vapors, can affect and penetrate the skin. The amount of toxin absorbed depends on skin condition factors, chemical quantity, concentration, total time contact is maintained, and the surface area and location of skin exposed to the hazardous substance.

Factor	Description
Skin Condition	Skin condition factors can increase susceptibility to further damage from toxins, as well as increase absorption into the body. This includes skin that has been previously damaged by trauma, heat, cold, humidity, or chemical exposure.
Quantity of Dosage	Absorption of materials through the skin is time dependent, which means the longer the contact, the more that will be absorbed. Usually, the longer the duration of exposure, the more severe the toxic response. Chlordane, malathion, and DDT are examples of chemicals that can cause cancer if the cumulative exposure is sufficient.
Local Factors	Local factors such as temperature and blood flow at the entry site will also influence the rate of absorption. High temperature conditions, such as found in chemical protective clothing, can actually increase the skin absorption rates of some chemicals.
Exposure Site	The site of skin in contact with the toxin is important since permeability differs according to body region. Areas rich in hair follicles, such as the scalp, forehead, jaw area and underarm, allow much greater absorption than do other parts of the body. The skin of the scrotum allows almost total absorption of some chemicals.
Enhanced Absorption	Absorption can be enhanced if the substance and skin are covered, for example by a bandage or clothing. Moisture due to sweat will also increase absorption.

Other factors that may influence the absorption of substances through the skin are:

- Contact between clothing and skin
- Humidity of the skin
- Increased temperature of the skin
- Damage to the skin (cuts, abrasions)

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- Use of solvents that facilitate penetration
- Altering pH of the skin
- Increasing toxicant concentration
- Decreasing toxicant particle size

Two Toxic Exposure Examples:

- 1) The same amount of mustard you would put on a hot dog, if placed on the skin (dermal exposure), would be a local irritant.
- 2) Cutting an onion results in eye irritation, yet no irritation to the hands.

Toxic Effects of Skin Absorption

Contact with a chemical substance by the skin may cause two major effects: 1) The Local Effects and 2) The Systemic Effects:

1) The Local Effects:	
Irritation	Many chemicals cause an immediate reddening, rash, or other irritation to the skin upon contact.
Tissue damage	Chemicals such as corrosives, including acids or bases, eat into the skin and cause damage to the tissue beneath it.
Allergic effects	Some chemicals, such as nickel, chromium, formaldehyde, turpentine, and isocyanates cause the skin to become hypersensitive after repeated exposures. This is called sensitization dermatitis.
2) The Systemic (internal) Effects:	Systemic effects from absorption through the skin. Many solvents are absorbed through the skin, circulated through the bloodstream, and then cause damage within the body.

Oral Exposure (The Digestive Tract Exposure Route)

The oral route is the third way a chemical can enter the body. The main point of entry of this type of exposure is through the mouth. The chemical then passes to the gastrointestinal (GI) tract, which can be thought of as a “tube” going through the body. Chemicals that are eaten, intentionally or accidentally, may be absorbed into the body through this “tube”. Ingestion is the most common route of entry in cases of suicide and childhood poisoning, but less likely in work and environmental exposures. However, ingestion can occur when substances or contaminated hands, or clothing, come in direct contact with the mouth. In addition, some toxins may be consumed by eating meals or smoking in an environment where food and cigarettes can become contaminated. Metals such as lead, cadmium and arsenic are absorbed following their ingestion.

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The cells that line your upper respiratory tract (bronchia, throat) have small hair-like projections called cilia. These cilia move back and forth to carry mucous from the lungs to the throat, where they may be swallowed or spit out. Dusts that were filtered out in your upper respiratory tract can be trapped in the mucus and moved to your mouth where you can swallow them. In workplaces where dust levels are very high, ingestion (swallowing) has been a primary route of exposure. For example, lead exposure in radiator shops has caused several cases of stomach cancer.

Absorption rates for the different regions of the GI tract will vary due to differences in pH and surface areas. Therefore, the region of greatest absorption will be different for different compounds. In the workplace, many people may eat or drink harmful chemicals without knowing it. Toxic (poisonous) materials are absorbed from the digestive tract into the blood stream.

Personal hygiene is essential for the hazardous waste handler. At a minimum this requires:

- Wash thoroughly before eating, drinking or smoking
- Eat, drink and smoke in clean areas only

Toxic Effects of Ingestion: When a toxin is ingested, it affects the entire gastrointestinal system, which includes the mouth, pharynx, esophagus, stomach, small intestine and large intestine, as well as several other organs within the gastrointestinal system. These organs are collectively responsible for the absorption, digestion and storage of nutrients for human life. Like all organs, the gastrointestinal system may also be effected by toxins that enter the body through the skin or lungs. Some of these toxins may cause liver toxicity resulting in inflammation or other diseases such as:

- **Cirrhosis:** Cirrhosis is a progressive disease of the liver, which may occur with chronic exposure to carbon tetrachloride, but the most common cause is chronic alcohol consumption.
- **Malignant tumors:** Vinyl chloride monomer (used in making the polymer of vinyl chloride) can cause malignant tumors of the liver. Other suspected liver carcinogens are DDT, dieldrin and trichloroethylene.

Dose/Response Relationship

The dose/response relationship is the basis for measuring of toxicity. This relationship rests upon three assumptions:

1. The response is a function of the concentration at a site.
2. The concentration at a site is a function of the dose.
3. The response and dose are causally related.

These assumptions are simply stating that for the dose/response to be valid, increasing the dose should increase the concentration at the site of toxicity. All toxicology studies are based on the dose-response relationship. This is an attempt to relate the amount of a substance (the dose) given to a test animal to the effect shown by the animal (the response). The following table displays the dose/response relationship:

Example of the Dose/Response Concept:

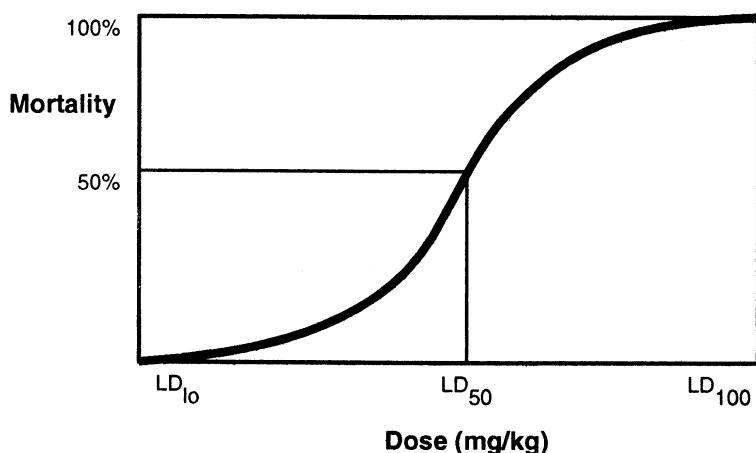
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Dose = Concentration	Time	Response
1 quart of 12% ethanol (alcoholic beverage)	15 mins.	brain effects ("drunk")
1 quart of 12% ethanol	daily	chronic organ damage
1 quart of 12% ethanol	annually	no observed effect

Note: The same dose given over a short period of time may have a substantial effect, while the same dose over a long period of time may have no effect at all.

Typical Dose-Response Curve

The mean response of a group at a particular dose is called the dose-response relationship. A way of representing the response of a population to different doses is with the sigmoid dose response curve. This curve compares the percentage of mortality among test subjects across a range of doses.



A basic piece of information available from the curve is the toxicity of the material. The curve shows that the effect of increasing the dose results in increased mortality of test subjects. Some individuals died at relatively low concentrations, while the hardest succumbed only at the highest dosage. The most toxic materials have the steepest curves, meaning that the difference in dosage between when the first death is observed, and where the entire population expired, is small.

Toxic Chemical Responses

The range of observable undesired effects resulting from exposure to a hazardous substance is broad. Some compounds may have numerous toxic responses. The identification of compounds by the type of response they cause can be quite useful. For example, compounds that cause delayed toxic effects may require more caution because they may give limited signs of exposure. Some chemical classifications are presented on the following page:

Immediate And Delayed Responses	
Immediate	Single administration, rapid onset (ethanol, nerve gases, aspirin)

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Delayed	Occur after a lapse of time (carcinogens - latency period 20 - 30 years)
Reversible and Irreversible	
Reversible	Re-establishment of normal function or regeneration of injured tissue (anti-cholinesterase, most liver toxicity because of the liver's ability to regenerate)
Irreversible	Permanent functional or tissue injury (teratogens, most CNS toxicity since differentiated cells cannot divide and be generated)
Acute and Chronic Responses	
Acute	Response following a single or short term exposure (acid, mace)
Chronic	Response following repeated small dose carcinogens (DDT, lead)
Local and Systemic Injuries	
Local	Injury at the site of first contact (caustic substances, inhalation of irritants)
Systemic	<ul style="list-style-type: none"> - Injury following absorption and distribution - Most systemic effects have one or two target organs <li style="padding-left: 40px;">Most frequent target: CNS, Next: circulatory system <li style="padding-left: 40px;">Least frequent: muscle and bone (lead - accumulated in bone - toxic in soft tissue DDT - concentrated in adipose tissue - no toxic effect there)
Synergistic and Antagonistic Effects	
Additive	The effect of two toxicants is equal to the sum of their individual effects (2 anticholinesterase, - malathion and carbaryl)
Synergistic	The combined toxicity is greater than the sum of the individual effects (carbon tetrachloride and ethanol; asbestos and smoking)
Antagonistic	Combined toxicity is less than the sum of the individual effects (atropine and nerve gas)

Toxins and their Effects

When a set of test animals is exposed to a given dose of a toxin, some may show minimal effect while others are more affected by the same dose. Any measure of the toxicity of a material must account for the mean, or average response of a population, rather than the particular response of an individual. Individual variabilities includes sex, age, individual susceptibility, nutrition, and health, which are explained in the table below:

Sex:	Males and females exhibit different responses. For example, females typically have higher body fat, and thus may be more susceptible to fat soluble substances. Males, on the other hand, may experience reproductive harm if the toxin targets rapidly growing cells. Females are susceptible to teratogenic and mutagenic
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	threats if pregnant, with the first trimester being the most vulnerable.
Age:	Metabolism of foreign compounds is an important detoxifying (and toxifying) process. For example, biochemical processes in the liver include the conjugation of glutathione (a protein) with the toxic compound to render it inactive and non-toxic. Older individuals tend to have lower glutathione levels and are less able to deactivate toxins. The greater the age of the individual, the more vulnerable they are to toxins. Respiratory and cardiac disease are more common in older individuals.
Individual Susceptibilities	Allergies or other physical impairments can increase one's sensitivity to particular chemicals. For example, occasionally someone may report reactions to household chemicals that otherwise wouldn't affect the general population. Obviously, the same may be true with industrial chemicals.
Nutrition & Health:	Physically fit persons are less susceptible to chemical exposures. The natural mechanisms that the body has for dealing with chemical exposures are at their peak when one is in good health. On the contrary, illness or poor health can mask symptoms from a chemical exposure. For example, a persistent cough may be attributed to a cold or flu, instead of a chlorine gas exposure.

Measurement of Exposure

The terms and definitions for measuring toxicity are an essential part of a hazardous waste responders vocabulary. This data represents the relative hazards of toxicants, allowing handler to make assessments about the threat of an incident. Generally, the lower the numbers, the more toxic the material.

When people think of a dose, they usually think of one vitamin a day, or two aspirins every four hours. This type of dosage would result in different exposures depending upon the size of the recipient. The use of laboratory animals in toxicity tests would result in even greater size disparities.

To provide a uniform measure of exposure, the dosage is usually expressed as a ratio of the weight of the chemical to the weight of the animal. In this way, it is possible to extrapolate the test animal dosage to humans.

Measures of Exposure (Dose)

Dose	Abbreviation	Metric Equivalent	Abbreviation
parts per million	ppm	milligrams per kilogram	mg/kg
parts per billion	ppb	micrograms per kilogram	ug/kg

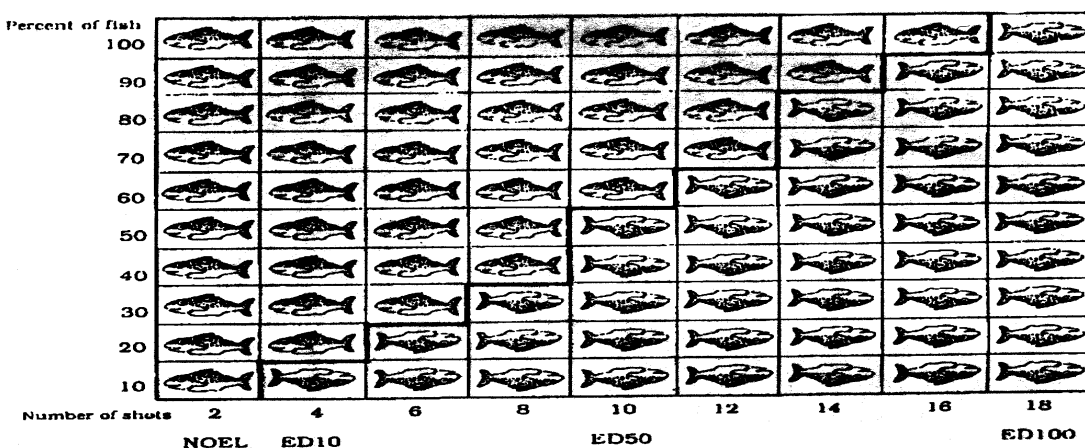
Lethal Dosage (LD-50) and Lethal Concentration (LC-50)

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The simplest toxicology study relates the percentage of test animals that die (mortality response) from the dose given. The dose is usually expressed in mg/kg (for ingestion or inoculation), in mg/M² (for skin exposure), or in mg/M³ (for inhalation). The response is expressed in percent (%) of animals that have died. The dose of a chemical that kills 50% of the test animals is the LD-50.

LC-50 is usually expressed in parts per million in air. It is the concentration that kills half the population in a given observation period. It is independent of body weight. The LC-50 measurement is used to determine the toxicity of vapors, fumes and dusts in air. The test procedure is very similar to LD-50 tests. The lethal dosage and concentration measures acute toxicity, and is commonly used to measure relative toxicity. The important thing to remember is that a **low LD-50 value indicates a more toxic chemical**, (i.e., 1 mg/M³) while a high LD-50 (i.e., 10,000 mg/M³) indicates a less toxic chemical.

An example of the dose/response relationship is illustrated by dumping shots of 100-proof whiskey into a ten-gallon tank containing ten goldfish. How many shots (dosage) will cause the fish to swim upside down? After one or two shots, none of the fish die, but after about four shots, one of the fish dies. As more shots of whiskey are added, more fish begin to die. After ten shots, five of the ten or 50% of the goldfish are swimming upside down. If the effect being observed is death, then the lethal dosage (LD-50) would be the measure of the lethal dose for 50% of the population.



High LD values describe chemicals that are less toxic. The following table displays some of the LD-50 values for several substances. Notice that Dioxin (TCDD) and Botulinus toxins are extremely deadly.

Approximate Acute LD-50's of a Selected Variety of Chemical Agents

AGENT	LD-50 (mg/kg)
Ethyl alcohol	10,000
Sodium chloride	4,000
Ferrous sulfate	1,500

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Morphine sulfate	900
Phenobarbital sodium	150
DDT	100
Picrotoxin	5
Strychnine sulfate	2
Nicotine	1
d-Tubocurarine	0.5
Hemicholinium-3	0.2
Tetrodotoxin	0.10
Dioxin (TCDD)	0.001
Botulinus toxin	0.00001

Probable Oral Lethal Dose for Humans: Hazardous substances can be ranked by their potential human toxicity. The table below describes the five different levels that are generally used to rate level of toxicity. It relates the lethal dosage for an average adult and the respective lethal ingested quantity:

Toxicity Rating or Class	Lethal Dose Concentration For Average Adult	Lethal Quantity For Average Adult
1. Practically non-toxic	> 15,000 mg/kg	More than 1 quart
2. Slightly toxic	5,000 -15,000 mg/kg	Between pint and quart
3. Moderately toxic	500 - 5,000 mg/kg	Between ounce and pint
4. Very toxic	50-500 mg/kg	Between teaspoon and ounce
5. Extremely toxic	5-50 mg/kg	Between 7 drops and teaspoon
6. Supertoxic	< 5 mg/kg	A taste (less than 7 drops)

OSHA establishes enforceable safety standards or criteria for chemicals that are designed to protect public health. The basis for the standard is usually a toxic response occurring at a much lower dose than where mortality occurs. Therefore, tests are devised to determine the dose which produces no observable adverse effects when small doses are administered over a period of time. Many standards and criteria have been established. However, they are all based on determining the dose level where toxic responses will not occur, and then dividing this dose by a safety factor to compensate for uncertainty.

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No Observed Effect Level (NOEL): The highest concentration or dosage where no effect is observed.

Threshold Limit Value - Time Weighted Average (TLV-TWA): This is the upper limit of a toxic material to which an average person, in average health, may be exposed on a day-to-day basis (40 hour work week, 8 hour work periods), with no adverse effects. TLVs are typically expressed in milligrams per cubic meter (mg/m³) for gases or vapors, and micrograms per cubic meter (ug/m³) for fumes and mists.

These are time weighted averages, and are not intended as a definitive line between safe and dangerous concentrations, but rather allow excursions above the TLV only when the average exposure does not exceed the TLV-TWA.

Threshold Limit Value - Ceiling (TLV-C): This is the maximum limit of a toxic material to which an average person in average health may be exposed on a day-to-day basis (40 hour work week, 8 hour work periods) with no adverse effects. This value is used in conjunction with TLV-TWA and represents the maximum limit of excursions above the TLV-TWA. TLV-C is considered allowable, provided the average exposure throughout the work week does not exceed the TLV-TWA.

Permissible Exposure Limit (PEL): This is the maximum permitted 8-hour time weighted average concentration of an airborne contaminant. The PEL is determined by OSHA and is equivalent in definition to the TLV-TWA which is set by the American Conference of Governmental Industrial Hygienists (ACGIH). The PEL is a legal limit, whereas the TLV is a recommended standard. Often they are the same values.

Short Term Exposure Limit (STEL): This is the maximum permitted exposure for no more than 15 minutes.

Immediately Dangerous to Life and Health (IDLH):

This is the concentration of airborne contaminants, normally expressed in parts per million (ppm) or milligrams per cubic meter, which represents the maximum level from which one could escape within 30 minutes, without any escape impairing symptoms, or irreversible health effects. This level is established by both the National Institute of Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH definition differs from NIOSH in that irreversible health effects are not considered. Therefore, carcinogenic compounds are not included in ACGIH IDLH listings.

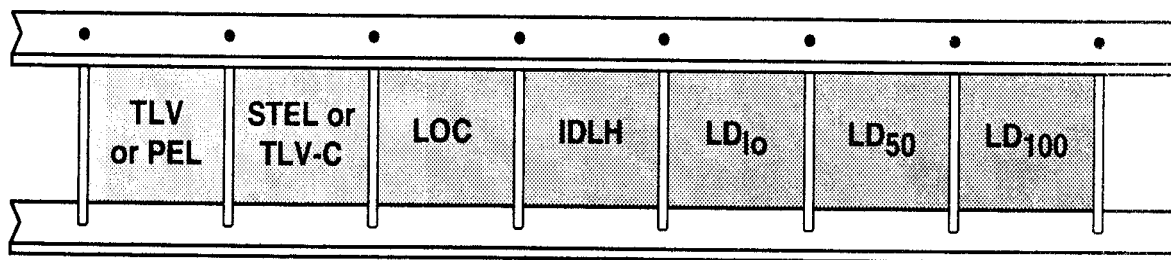
Maximum Allowable Concentration (MAC): Absolute maximum exposure (ppm) at a given time.

Level of Concern (LOC): This value is used to determine the geographic area of risk in the event of a chemical release. LOC is generally defined as IDLH/10. Typically, evacuation or protection measures may be necessary in LOC conditions.

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Limit	Exposure Duration	Legally Mandated?	Comments
TLV	8 hours per day up to 40 hours per week	No	Set by ACGIH
PEL	8 hours per day up to 40 hours per week	Yes	Set by OSHA
STEL	15 minutes	Yes	Set by OSHA
IDLH	30 minutes for escape only	No	Determined by NIOSH
LOC	None	No	Evacuation Guideline

One way to visualize the relative ranking of the various toxicity terms for a material is the hazard ladder. Each toxicology value is arranged in order of increasing concentration and severity. TLVs for example, are the lowest numbers and they represent levels which cause relatively minor effects. Conversely, LD-100 values are comparatively large and fatal.



Emergency Response Planning Guide (ERPG)

Hazardous concentrations have been developed for emergency response situations where response individuals may be exposed for short periods of time. These ceiling limit values are developed and recommended by the American Industrial Hygiene Association (AIHA). The ERPG limits are not intended for repeated or extended exposures. The three levels are defined as follows:

ERPG-1: Maximum airborne concentration to which nearly all individuals could be exposed for up to one hour, without experiencing or developing health effects more severe than sensory perception, or mild irritation.

ERPG-2: Maximum airborne concentration below which, it is believed, nearly all individuals could be exposed for up to one hour, without experiencing or developing irreversible, adverse or other serious health effects or symptoms which could impair an individual's ability to take protective action.

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ERPG-3: Maximum airborne concentration below which, it is believed, nearly all individuals could be exposed for up to one hour without experiencing or developing life threatening health effects.

The MSDS: “A Valuable Tool For Determining a Substance Toxicity”

The Material Safety Data Sheet (MSDS) is the primary source of technical information concerning safe handling procedures and health affects of a chemical. According to OSHA Hazard Communication Standard (HCS) regulations, an MSDS must be readily available near the work station for every hazardous chemical used. Employees must know how to obtain an MSDS, and must be trained on how to interpret them. Since the central role of the MSDS is to provide hazardous material safety information, it is important that the hazardous waste handler understands how to read them effectively.

This training session provides a section by section review of the MSDS and the kind of information that must be provided by companies furnishing MSDSs. Although, the format of many MSDSs may be somewhat different, each MSDS must contain all these elements. The following table provides an outline of a typical MSDS and the subjects contained in each section:

MSDS SECTION	OUTLINED INFORMATION
SECTION I MANUFACTURER / PRODUCT IDENTIFICATION	Product name Address of manufacturer’s importer or other party responsible for preparing the MSDS Emergency and non-emergency telephone numbers The date prepared or last changed
SECTION II HAZARDOUS INGREDIENTS/ IDENTITY INFORMATION	Hazardous chemical names Chemical identity CAS #, and concentration (%) OSHA PEL limits in air ACGIH TLV limits in air
SECTION III PHYSICAL/CHEMICAL PROPERTIES	Vapor density Melting point or range Specific gravity Boiling point or range Solubility in water Appearance and odor Warning properties
SECTION IV FIRE AND EXPLOSION HAZARD DATA	Flash point Auto-ignition temperature Lower explosive limit (LEL) Upper explosive limit (UEL) Special fire fighting procedures Fire extinguishing materials Unusual fire and explosion hazards
SECTION V HEALTH HAZARD	Symptoms of overexposure for each route of exposure How to recognize exposure Acute and chronic effects of exposure

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INFORMATION	First Aid Emergency Procedures for exposure Suspected carcinogens (yes or no) Medical conditions aggravated by exposure
SECTION VI REACTIVITY DATA	Product stability Conditions to avoid Materials to avoid Hazardous decomposition Hazardous polymerization
SECTION VII SPILL LEAK & DISPOSAL INFORMATION	Spill response procedures Proper disposal of spilled wastes
SECTION VIII PRECAUTIONS FOR SAFE HANDLING AND USE	Ventilation and engineering controls Respiratory protection Eye protection Clothing and equipment Hand protection (gloves) Good work practices, handling, and storage requirements Decontamination of equipment
SECTION XI LABELING	DOT shipping name Precautionary statements NFPA hazard rating

The following describes the MSDS sections, outlines information presented, identifies key terms, and provides for a better MSDS understanding.

SECTION I - MANUFACTURER'S IDENTIFICATION

The first section of the MSDS contains the name and address of the chemical manufacturer, importer or party responsible for preparing the MSDS. Both emergency and non-emergency telephone numbers are provided for obtaining additional information on the hazardous product. The date that the MSDS was prepared or last changed should also be included in this section.

The most important information contained in this section is the emergency information phone numbers. This gives the caller access to an individual that should be educated about the product and associated health risks, clean-up procedures, and personal decontamination. The person at the emergency phone should be able to clarify the information provided on the MSDS over the phone.

SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Any chemical substance that has been found to present a physical or health risk must be identified on the MSDS by its specific chemical name and its common name. Chemical mixtures that have been tested as a whole, and have been determined to be hazardous, must be listed by the chemical and common names of the components that contribute to the hazard(s), as well as the common name(s) of the mixture. Mixture ingredients which have been identified as carcinogens or potential carcinogens by the National Toxicology Program (NTP), the International Agency for Research

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on Cancer (IARC) or OSHA, and comprise 0.1 percent, or greater, of the total mixture composition, must also be listed and identified by both the chemical and common names. The table below provides a description of the key terms that will be encountered in this section of the MSDS.

Key Terms	Description
ACGIH	American Conference of Governmental Industrial Hygienists is a private organization of occupational safety and health professionals. ACGIH limits are usually lower (more stringent) than OSHA limits, but are not legally enforceable.
OSHA	Occupational Safety and Health Administration is the federal agency which sets safety and health standards and regulates working conditions in most of the nation's workplaces.
CAS#	The Chemical Abstracts Service Registry Number is a number given to each chemical that identifies it as a specific chemical compound.
PEL	Permissible Exposure Limit is the amount of any chemical to which a worker can legally be exposed. It can be an average exposure over time, or a one-time maximum exposure limit. This limit is established by OSHA.
TLV	Threshold Limit Value is an exposure limit recommended by ACGIH. There are three types of ACGIH TLVs : TLV-TWA -The allowable Time-Weighted Average concentration for an eight hour work day. TLV-STEL -The Short-Term Exposure Limit, or maximum average concentration, for a continuous 15 minute exposure period. TLV-C -The Ceiling Limit, or maximum concentration, that should not be exceeded even for a split second.
Ppm	Parts per million, or parts of the chemical per million parts of air.
mg/m³	Milligrams per cubic meter. This is the weight of the chemical (usually a dust or vapor) in a particular volume of air.

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

This section of the MSDS requires the inclusion of several important physical/chemical characteristics of the hazardous substance. Among these are the boiling point, melting point, specific gravity, vapor pressure, evaporation rate, vapor density and solubility. The physical appearance and odor of the compound are also required information. This is very important for both hazard recognition and emergency response analysis. The table below provides a description of the key terms encountered in this section of the MSDS.

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Key Terms	Description
Boiling Point	The boiling point of a chemical or chemical mixture is the temperature at which the vapor pressure of a liquid equals the atmospheric pressure. Therefore, it is the temperature at which the substance rapidly changes from a liquid to a gas. The lower the boiling point, the more quickly it will evaporate and emit potentially harmful vapors into the air.
Melting Point	The melting point is the temperature at which a solid will be in equilibrium with the liquid phase at atmospheric pressure. At this temperature, a solid will begin to flow like a liquid.
Evaporation Rate	The time required to evaporate a certain volume of a liquid chemical compared to the time required to evaporate the same volume of a reference liquid (usually ethyl ether). In general, the higher the evaporation rate, the lower the boiling point, and the greater potential for release of hazardous vapors.
Solubility	The solubility of a substance in water should be reported as the percentage of product (by weight) that can be dissolved in distilled water at a specified temperature.
Specific Gravity	Specific gravity is the ratio of the density of a liquid, or solid, to the density of an equal volume of water at a specified temperature. A substance with a specific gravity <1.0 will float on water, while substances with specific gravity >1.0 will sink in water.
mmHg	Millimeters (mm) of the metal mercury (Hg) is a unit of measurement for pressure. For example, when used to define vapor pressure, it shows how likely a liquid is to vaporize. At sea level, the earth's atmosphere exerts 760 mm Hg of pressure.
Vapor Density	Vapor density is expressed as the density of chemical vapor relative to that of air, which is assigned a vapor density of 1.0. Knowledge of the vapor density of a chemical product will allow the waste handler to determine whether the vapor will rise or sink in the ambient air. A chemical with a vapor density less than 1.0 will rise in air, while a chemical with a vapor density greater than 1.0 will tend to sink in air and "flow" along the ground, collecting in puddles.
Vapor Pressure	Vapor pressure refers to the pressure (expressed in mmHg) exerted by a chemical vapor in equilibrium with its liquid or solid phase at any given temperature. Information on vapor pressure can provide the waste handler with an indication of how easily a chemical can become airborne. The higher the vapor pressure, the more likely it is that significant quantities of a chemical will be airborne, if it escapes. High vapor pressure is greater than 10 mmHg. Low vapor pressure is less than 1 mm Hg.
Appearance	The appearance and odor of a chemical product is identified by using the

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nce and Odor	appropriate descriptive terminology. For example: viscous, colorless liquid with an aromatic odor.
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SECTION IV - FIRE AND EXPLOSION HAZARD DATA

The MSDS should detail any unusual fire or explosion hazards that are inherent to the hazardous substance or dangers that may be initiated by a change in environmental conditions. The information that is required for chemicals is the flash-point, flammable limits, lower exposure limit (LEL), upper exposure limit (UEL), recommended extinguishing media, special fire fighting procedures, and unusual fire and explosion hazards. Some chemicals, for example, known as pyrophorics, can ignite spontaneously when they come in contact with air. No flame or spark is needed, which must be identified on this section of the MSDS. The table below provides a description of the key terms that will be encountered in this section of the MSDS.

Key Terms	Description
Combustible	Able to catch fire and burn. Moderate fire risk chemicals with a flash-point between 0°F. and 200°F. are considered combustible.
Flash-Point	The lowest temperature at which a liquid gives off enough flammable vapor to ignite (start to burn) if it comes in contact with a spark, flame or other ignition source. If the flash-point is less than 100°F, a cigarette or static electricity could start a fire. A chemical whose flash-point is less than the temperature of the area where it is used or stored, poses a problem.
Ignition Temperature	Ignition temperature is the minimum temperature required to initiate self-sustained combustion of a material. This temperature may be the same as the flash point but is usually slightly higher.
Auto-ignition Temperature	The auto-ignition temperature is the lowest temperature in which a material will spontaneously ignite and burn. In this situation, heat is the only source of ignition. For most materials, the auto-ignition temperature tends to be high (several hundred degrees Celsius). However, some material, such as white phosphorus, will ignite at temperatures close to room temperature.
Flammability Limits	Flammability limits are the lowest and highest concentrations (%) of vapors in air that will produce a flash fire when an ignition source is provided. Its unit of measurement is percent by volume in air. At a concentration too low to ignite, the mixture is too "lean" to burn. At a concentration too high to burn, the mixture is too "rich" to burn.
Flammable and Explosive	Flammable or explosive limits refer to the range of vapor concentrations in the air (percent by volume) that will burn or explode upon contact with an ignition source. The Lower Explosive Limit (LEL) is the lowest vapor concentration in the air which will explode if heated. The Upper Explosive Limit (UEL) is the highest vapor concentration in the air which will explode if

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	heat is added. The explosive range between the LEL and UEL indicates the degree of hazard. The greater the range, the greater the hazard. The LEL is an important factor to be considered when calculating the volume of air needed to ventilate an enclosed space to prevent fires and explosions.
Oxidizer	A chemical which gives off oxygen. Oxygen feeds fires, and can cause materials that are normally hard to burn to burn more easily and at higher temperatures. Oxidizers should never be stored near flammable or combustible materials.
Extinguishing Media and Procedures	Extinguishing media specific to the particular chemical compound must be identified on the MSDS. Common extinguishing agents include water, foam, halon, carbon dioxide, dry chemicals, and powders. Any special procedures that may be useful to firefighters and other emergency response personnel (i.e., Do Not Use Water) should be reported.

SECTION V - HEALTH HAZARD DATA

This section of the MSDS introduces a variety of information to help the hazardous waste handler understand the effects of exposure. All chemicals can be handled safely, and the human body can, and does, withstand low level exposures to toxic compounds. This section will provide an interpretation of "low level" exposures for the chemical compound. Key terms that are required in this section of the MSDS are listed in the following table:

Key Terms	Description
Routes of Exposure	Routes of chemical exposure include inhalation, ingestion, and absorption. It is important to identify any and all of the potential routes of entry for chemical exposure.
Exposure Signs	Exposure signs describe how an overexposed individual is most commonly affected by the chemical. This should include any obvious physical indications as well as any subjective complaints that can be reasonably attributed to the exposure, such as headaches, burns, rashes, difficulty breathing, and dizziness.
Acute and Chronic Health Hazard	Acute and chronic health hazard data should include any health hazards for which there is statistically significant evidence, based on at least one positive study conducted in accordance with scientific principles.
Acute Exposure and Effects	Acute effects occur immediately or in a short interval after exposure. They are typically sudden and severe (illness, irritation, and/or death) and are characterized by rapid absorption of the material. Acute effects are usually due to acute short-term exposures.
Chronic	A chronic effect is one that develops slowly over a period of time, or which

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Exposure and Effects	recurs frequently. Chronic exposure means a relatively low level of exposure which occurs over a relatively long period of time.
Aggravated Medical Conditions	Medical conditions that may be aggravated or worsened by exposure to a chemical must be identified on the MSDS. Such conditions may include high blood pressure, asthma and other chronic respiratory conditions, diabetes, allergies, skin disorders, and liver and kidney problems.
Emergency and First Aid Procedures	Emergency and first aid procedures must be specified on the MSDS for the purpose of providing information on the immediate steps to be taken in the event of a medical emergency, until a qualified medical professional can examine the victim.
Carcinogen	A chemical or physical agent capable of causing cancer.
LD-50	The dose of a chemical that will kill 50% of the test animals receiving it. The chemical may be given by mouth (oral), applied to the skin (dermal), or injected (parenteral). A given chemical will generally show different LD-50 values depending on the route of administration and the species of the test animal. This measures acute toxicity.

SECTION VI - REACTIVITY DATA

Reactivity data includes information on chemical stability, incompatibility, decomposition, conditions to avoid and hazardous polymerization. The MSDS should indicate whether the chemical is stable or unstable under reasonable conditions of storage, use, or misuse. It also should indicate whether or not the chemical will react readily with air or change its chemical structure when exposed to various combinations of temperature, pressure and light conditions. MSDSs should identify those conditions to be avoided when handling unstable chemicals. The table below provides a description of the terms used in the reactivity data section of the MSDS.

Key Terms	Description
Stability	A material's ability to remain unchanged. The substance is considered stable if it remains in the same form under reasonable conditions of storage or use. Conditions which may cause dangerous changes are stated on the MSDS. High temperatures or shock from dropping can cause violent reactions.
Reactivity	The ability of a substance to undergo a chemical change by reacting with other substances or by decomposing. Either change can create a potentially hazardous chemical.
Incompatible Materials	Incompatible materials are chemicals or materials that can initiate a potentially dangerous reaction when brought into contact with an otherwise stable substance. The MSDS should identify any such incompatible materials and their attendant hazards.

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Hazardous Decomposition	Hazardous decomposition is the breakdown of a chemical substance into simpler chemical products. If the decomposition products are hazardous, the MSDS should explain the conditions that may cause decomposition and name the by-products.
Hazardous Polymerization	Hazardous polymerization is a chemical reaction where molecular units of a chemical bond together under certain conditions to form a long chain called a polymer. Hazardous polymerization may occur when a reaction takes place at a rate that releases enough energy in the form of heat to cause a fire or explosion. Some chemicals can expand and burst their containers during a polymerization reaction. To help prevent hazardous polymerization, information about time periods for which the chemical inhibitor will remain effective must be noted on the MSDS.

SECTION VII - SPILL, LEAK, AND DISPOSAL INFORMATION

Proper precautions for the safe handling and use of a chemical product must be indicated on the MSDS. This includes the steps to be taken in case the material is released or spilled, appropriate waste disposal methods, precautions to be taken in handling and storing the material, and any other safety precautions.

Response procedures for the clean-up of leaks, spills and other accidental chemical releases may include:

- Remove sources of ignition
- Avoid breathing of gases and vapors
- Provide additional ventilation
- Avoid contact with liquids and solids
- Isolate contaminated areas
- Evacuate unauthorized personnel
- Dike materials for spills
- Knock down vapors with water spray
- Apply absorbent material
- Sweep and decontaminate all areas

Appropriate waste disposal methods should also be specified on the MSDS for wastes that are created during spill clean-up and/or production operations. All waste should be disposed of in accordance with Federal, state, and local regulations. The MSDS will never provide specific information about proper disposal because of the potential for a variety of waste stream contaminations and the variations in local and state requirements. All hazardous waste in the shipyard should be segregated and processed in the central accumulation area for proper disposal.

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SECTION VIII - CONTROL MEASURES AND SPECIAL PRECAUTIONS

This section of the MSDS requires information on the recommended control measures for reducing worker exposure to the hazardous substance. Some of the control measures may be described are:

Key Terms	Description
Ventilation and Engineering Controls	Engineering controls are the workers first line of defense against chemical exposures in the workplace. Ventilation systems, special enclosures, and other mechanical protection systems are all examples of engineering controls. Ventilation systems may be of the local exhaust type, which captures and removes contaminants at the source, or the general dilution type, which reduces contaminant levels by circulating fresh air through the work environment. The MSDS can indicate whether these or any other types of specially designed ventilation systems are of use in the workplace.
Personal Protective Equipment (PPE)	Personal protective equipment (PPE) usually includes gloves, safety glasses or goggles, face shields, aprons, boots, and respiratory equipment. Specific information should be given on the exact type of respiratory protection to be worn for every possible level of exposure. Protective gloves and eyeglasses are available in a variety of materials. The MSDS should specify a certain type of eye protection or glove material to be used with any given chemical. Any other special protective clothing or equipment that is known to the manufacturer should be noted on the MSDS.
Other Hygiene Information	Any relevant hygienic and/or work practices which can be employed to protect employee health and safety should also be reported.

SECTION XI - LABELING

This section generally provides precautionary statements that also appear on the chemical container label. This is very useful as it brings a primary source of information, the label, together with the technical information on the MSDS. It also provides other information for emergency responders in the event of a spill, release, or contamination. Some other information is as follows:

- DOT shipping name
- United Nations Shipping Number
- Precautionary statements (Statement of Hazards) (Signal Word)
- NFPA Hazard Ratings
- HMIS Hazard Ratings

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Title:

Safe Handling Practices for Hazardous Waste Handlers

Objective of this Training Session:

To provide the Hazardous Waste Handler with the information required to safely conduct routine operations involving hazardous waste.

Introduction: The safe handling of hazardous waste is vital to the hazardous waste handlers' job. Risks from exposure to chemical hazards (such as toxicity) and physical hazards (such as fire) will be present when hazardous waste is handled. These risks must be managed to acceptable levels. Fortunately, the safety procedures for avoiding the hazards of hazardous waste are the same for avoiding any chemical hazards. Remember, any chemical (or waste) can be handled safely if the hazards are known and proper precautions are taken.

Flammable and Explosive Wastes: Many chemicals and chemical wastes have the ability to catch fire and burn. Common products used by industry that are flammable include solvents, paints and adhesives. These products and other flammables can become wastes and must be managed in such a manner so as to prevent the possibility of fire or explosion during handling or storage. The basis of safe handling of flammable wastes is the understanding of how and why things catch fire and burn. From this understanding, we can control the risk.

Burning is the rapid oxidation of a fuel by an oxidizer (usually air) with the liberation of heat and (usually) light. The fuel is usually present in the gaseous state, though finely divided liquids and solids can burn.

The process of burning involves three interrelated components: fuel, oxidizer, and ignition source. These three components make up the FIRE TRIANGLE. For a fire to occur, all three sides of the triangle must be present.



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For practical purposes, the fuel (any substance capable of burning) and the oxidizer (usually air) must be present in sufficient quantity to form an ignitable mixture. To complete the triangle, the ignition source, containing sufficient energy to initiate combustion, must be present. The ignition source need not be in the form of a flame or spark; heat alone can supply the energy.

Typical examples of these three interrelated components are listed in the following table:

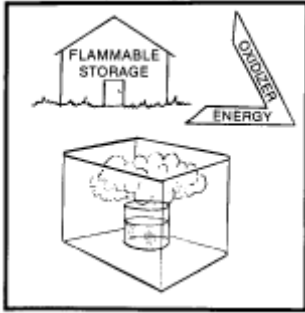
Examples of Necessary Components for Initiating Fire		
Fuels	Oxidizers	Ignition Sources
Flammable Liquids Acetone Alcohol Hexane Ether Toluene Pentane	Gaseous Oxygen Fluorine Nitrous Oxide Oxygen Difluoride Ozone	Sparks Flames Static Electricity Heat Electrical Equipment Cigarettes Light Bulbs Heaters Lightning Catalytic Surfaces Lasers Self Heating
Flammable Solids Plastics Fibers Wood/Paper Dusts Pyrophoric Metals	Liquids Hydrogen Peroxide Nitric Acid Perchloric Acid Bromine	
Flammable Gases Acetylene Propane Carbon Monoxide Hydrogen Ethylene Oxide	Solids Metallic Perchlorates Metallic Peroxides Ammonium Nitrate Ammonium Nitrite	

Control of Flammable Waste Hazards: The control of the fire hazards of flammable waste involves removing, or otherwise making inaccessible, at least one side of the fire triangle or blocking the chemical reaction itself.

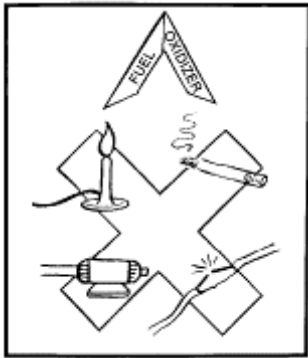
Removal of the oxidizer (usually air) is typically the most difficult to achieve. When it must be done, it is usually accomplished by displacing the air in the container or treatment tank with an inert gas such as nitrogen or carbon dioxide.

Removing the fuel is a somewhat easier approach. Store flammable wastes in areas which are well ventilated to prevent the build-up of vapors. When possible, work with flammable wastes when the ambient temperature is 10-12 C below the flash point. Keep cans, drums and other containers tightly closed to prevent their vapors from escaping into the work area.

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Removing the ignition source is often the easiest approach to help eliminate hazards. It should be done routinely, but the other approaches should also be used simultaneously. Be aware of all potential sources of ignition in the areas that flammable wastes are managed and/or stored. Remove or isolate all sources of ignition prior to any operation or storage of flammable wastes.



Rules for Managing Flammable Wastes:

- Keep flammable wastes away from all sources of heat, sparks and sources of ignition.
- Keep containers closed, except when actively adding or removing material from the container.
- Ground all metal drums and transfer vessels.
- Ensure their adequate ventilation to keep the concentration of flammable vapors from getting high enough to burn.
- Always use non-sparking tools when working with containers of flammable waste.
- Ensure all waste containers are properly identified and labeled.
- Maintain adequate spill clean-up equipment and media in the area where wastes are managed.
- Use vapor suppressing spill control media when cleaning-up flammable waste spills.

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- Minimize the quantity of flammable waste stored on-site to the maximum extent possible.
- Maintain adequate and proper fire suppression equipment in the area where flammable wastes are managed and stored. Ensure all hazardous waste handlers are properly trained to use portable fire extinguishers.

Reactive wastes: Reactive chemicals are substances which enter into violent reactions during which the spontaneous liberation of heat and/or gases is too rapid to be safely dissipated by the surroundings. Thus, the reaction is out of control and either the container bursts, an explosion occurs, toxic vapors are uncontrollably liberated, flammable gas is evolved, spontaneous ignition occurs, or any number of similar incidents occur. We will categorize reactive chemicals in two groups:

- a) Unstable Compounds
 - i) Explosives (e.g., TNT) - Explosives are substances which, under certain conditions of shock, temperature or chemical reaction, decompose with violent rapidity, usually releasing large quantities of gases, and heat. The process of explosion causes the rapid expansion of surrounding air, sometimes accompanied by burning gases and flying objects. This process is usually destructive to both life and property. High explosives detonate at rates up to four miles per second, while low explosives detonate at rates of only thousands of feet per second.
 - ii) Others (e.g., monomers) - Some chemical compounds may not always decompose explosively but still can cause appreciable damage. Some chemicals, called monomers, can react with each other in a chain reaction which can generate heat and gas. If confined in a closed container, this reaction could cause the container to burst with explosive force.
- b) Unstable Mixtures
 - i) Explosives are generally purposely mixed oxidizers and reducers, such as black powder. Waste explosives should only be handled by trained personnel that understand the risks, and use the proper equipment and techniques to handle the waste safely.
 - ii) Water-Reactive Compounds are chemicals that can react violently with water, often releasing flammable and/or toxic gases. Compounds which are water reactive should not be stored where automatic sprinkler systems are installed. They should be properly desiccated whenever possible and isolated from other reactive compounds.
 - iii) Air-Sensitive Compounds - These are chemicals that react spontaneously with oxygen in the air. Many air-sensitive compounds are also pyrophoric as well, so that they will burst into flames on contact with air. Examples of air-sensitive compounds include metallic dusts (zinc, nickel, titanium) and alkali metals (cesium, potassium)

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- iv) Other Mixtures of Oxidizing Agents with Reducing Agents - Strongly oxidizing and reducing chemicals will react violently if mixed together . This information is particularly important for the hazardous waste handler, who must ensure that these incompatible chemicals are not accidentally mixed during waste handling operations. The table below lists some of the more commonly used chemicals that are strong oxidizers and reducers.

STRONG OXIDIZERS		STRONG REDUCERS
Fluorine	Nitrous Oxide	Finely Divided Metals
Ozone	Liquid Oxygen	Hydrazine
Chlorine	Liquid Air	Hydrides
Persulfates	Chlorosulfonic Acid	Hydrogen
Peroxides	Nitromethane	Aniline
Peroxy Acids		
Perchlorates	Hypochlorites	Sodium
Dichromates	Chlorates	Lithium
Chromates		Potassium
Permanganates		Butadiene
Hypochlorites		Acetylides
Nitrates		

Rules for Managing Reactive Wastes:

- Handle and store the minimum amount possible
- Isolate reactive wastes from all other materials and wastes.
- Do not mix reactive or incompatible wastes.
- Provide for secondary containment for containers, piping and systems used to store or manage reactive wastes.
- Prevent contact of reactive wastes with combustible materials.
- Ensure all equipment and containers are compatible with the reactive waste prior to any waste handling or storage operations.
- Use inert containers and/or drum liners for storage of reactive wastes.
- Do not mix plural component product wastes (such as epoxy paints and adhesives) in the same container.

Toxic wastes: Toxic wastes include any material that can damage your health if you are exposed the chemical at a dose and frequency that results in damage to a biological structure or function. We control the risk from toxic wastes by ensuring exposures are controlled and limited. This is typically accomplished by using both engineering controls and personnel protective equipment and clothing.

Engineering Controls - Ventilation is the most common and effective form of engineering control used to eliminate or reduce exposure to toxic fumes, vapors, mist

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and/or gases. Ventilation can be effectively used to both remove toxic gases from the work area by suction, and then discharging the contaminants to an other area or control device, or by blowing clean air into the work area which reduces the concentration of contaminants by dilution.

Other engineering controls used to prevent getting toxic waste materials on, or in, a person include using equipment such as pumps and hoses, funnels and splash guards to reduce the potential for accidental contact from splashes.

Personal Protective Equipment - Personal Protective Equipment (or PPE) is used to protect the hazardous waste handler from toxic wastes in the event that engineering controls cannot be completely effective in reducing the potential exposure. PPE is also used to protect the worker if in the event that the chemical hazards associated with a waste are not completely known. PPE also protects in the event of an accident or spill involving toxic waste in the operations area.

The proper level of PPE required is dependent on the specific chemical hazards and possible routes of exposure associated with a waste, and the operations being conducted. For this reason, it is best to have the risks evaluated by an industrial hygienist or safety professional who can recommend the appropriate PPE for the material and tasks in question. In some cases, monitoring of the potential hazards may be necessary to properly determine the appropriate type(s) of PPE.

The basic PPE ensemble usually includes the following:

1. barrier clothing or suit to prevent physical contact of chemicals with the body;
2. feet and hand protection appropriate for the material and work task;
3. eye protection to prevent chemical contact and impact injuries;
4. head and face protection to protect these areas from impact and splashes; and,
5. respirator protection to prevent inhalation of toxic contaminants.

Once the appropriate type and combination of PPE has been established for a particulate waste material and work task, the same PPE can be used for the same operations in the future.

Physical Hazards: In addition to the chemical hazards associated with the handling of hazardous wastes, hazardous waste handlers must be aware of, and take the necessary precautions against the physical hazards of equipment and processes they operate and conduct. These include all the normal and usual hazards in the operation of mechanical equipment such as cutting, crushing, pinching, and abrasion injuries. Additionally, there are physical hazards associated with working in PPE such as the increased potential of heat stress.

In order to reduce the risk of physical injuries, the hazardous waste handler must follow the normal safety rules for material handling and equipment operation just as any other worker. The movement of drums and other heavy containers must be done in such a manner so as to prevent “tip-overs” or other movements of the container which can potentially cause pinching or crushing injuries. Drum dollies and forklifts should be used to prevent lifting injuries to the back.

The waste handler must know the operational capacity of the equipment he/she is using. Never attempt to exceed the operational capacity of any mechanical device such as chain lifts, can splitters or drum crushers. All equipment safety devices and guards must be in-place and operational prior to conducting operations.

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Heat stress caused by working in protective clothing can be life threatening. If PPE is required during hazardous waste handling tasks, schedule periods of cool-down and hydration on a frequent enough basis so as to prevent injury caused by excessive body temperature. Three levels of acute heat effects are recognized. These are:

- Heat cramps involve muscular pains and spasms due largely to loss of salt from the body by sweating, or to an inadequate intake of electrolytes.
- Heat Exhaustion is a response to heat characterized by fatigue, weakness, and ultimate collapse due to insufficient water intake to compensate for fluid lost via sweating.
- Heat Stroke is a response to excess heat characterized by extremely high body temperature and disruption of the sweating mechanism. Heat stroke is an immediate, life-threatening emergency for which cooling and medical care is urgently needed.

You can significantly reduce the potential for heat stress injuries by remaining aware of your body's response to working in PPE. If at any time you feel the symptoms of heat stress while working, take all necessary actions to stop work, cool down, replace water and electrolytes or seek medical attention.

Title:

Hazardous Waste Determination

Objective of this Training Session:

The purpose of this module is to provide hazardous waste handlers with a basic understanding of the regulatory definition of the term hazardous waste, and with knowledge of the procedures that they should follow to determine if wastes are hazardous.

Introduction: Generators of waste are required to determine if waste meets the definition of hazardous, and therefore is a hazardous waste. If a waste meets this criteria, then, all applicable requirements for the handling and management of hazardous waste must be met. Consequently a “waste determination” is a critical step in both the proper management and maintenance of regulatory compliance.

Waste Definitions: To some extent, the point at which a product or material becomes a waste is in the eye of the beholder. That is to say, one man’s garbage can be another man’s useful material. For this reason, the EPA has developed a precise definition of both the terms “waste” and “hazardous.” We use these definitions to determine when something becomes a waste (and possibly also hazardous), and to determine when it becomes subject to waste management regulations. Therefore, it is important that hazardous waste handlers know and understand these terms and their regulatory definitions.

Solid Waste - are any discarded materials (which are not excluded), including:

- Abandoned materials, including those which are:
 - Disposed;
 - Burned or incinerated; and
 - Accumulated, stored or treated prior to, or instead of, being disposed, burned, or incinerated.
- Recycled materials.
- Inherently waste-like materials (containing toxic constituents).

Note: Exclusions include domestic sewage and industrial wastewater discharges regulated under the Clean Water Act (40 CFR 261.4(a) |40CFR261.4.a|).

Note: “Solid” wastes can be liquids, solids, semisolids, or contained gases.

You will note that this definition of waste is not based on any physical or chemical characteristics of the material or product in question, but rather on the action that is being taken with regard to the material. That is to say, even if a material is still good for its intended purpose, if it is discarded or disposed of, then it is a solid waste.

To some extent, this can raise some contextual difficulties in defining something as a waste. For example, most drain cleaners contain potassium hydroxide, a caustic chemical which can dissolve

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grease and other drain pluggers. Potassium hydroxide is also hazardous. If you use this drain cleaner in the facility to clean drains on Monday, this is perfectly legal. If you pour the drain cleaner down the drain on Tuesday for the purpose of discarding it, you may have illegally disposed of a hazardous waste. The chemical properties of the drain cleaner were the same on each day. The action taken was the same on each day. Only the intent of the action changed from the first day to the second.

Hazardous wastes - are waste materials, which when improperly disposed, could harm people or the environment. For a waste to be a hazardous waste it must be:

- A “solid waste” which has not been excluded; and
 - ◊ A listed hazardous waste; or
 - ◊ A characteristic hazardous waste, including:
 1. A waste which exhibits ignitability (40 CFR 261.21 |40CFR261.21|); or
 2. A waste which exhibits corrosivity (40 CFR 261.22 |40CFR261.22|); or
 3. A waste which exhibits reactivity (40 CFR 261.23 |40CFR261.23|); or
 4. A waste which exhibits toxicity in accordance with Toxicity Characteristic Leaching Procedure (TCLP) (40 CFR 261.24 |40CFR261.24|).
 - A mixture of hazardous and solid wastes, including:
 - ◊ A mixture of a solid waste and a listed hazardous waste, subject to very limited exclusions;
 - ◊ A mixture of a solid waste and a characteristic hazardous waste if the mixture still exhibits the characteristic.
- Note:** Knowingly diluting a hazardous waste for the purpose of avoiding hazardous waste regulations is prohibited.
- Wastes or residues derived from the treatment, storage, or disposal of a listed hazardous waste (includes sludge, ash, dust, leachate, spill residue, etc.) are hazardous wastes.

Based on the two definitions given above, it is apparent that no material is a hazardous waste unless it is a solid waste. However, not all solid wastes are hazardous wastes. Nevertheless, as the definition of a solid waste is quite broad, few industrial waste streams would fail to meet it, except for the few wastes that are specifically excluded.

Given that most wastes will be solid wastes, the next step is to determine if the waste is a hazardous waste. As indicated in the definition above, a waste is hazardous if it is a listed waste or if it has certain hazardous characteristics. When making a waste determination, one must ensure that the waste is evaluated from both perspectives, that is, is the waste listed, and if not, does the waste have the characteristic of being hazardous.

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Listed Wastes - The list of Listed wastes is contained in 40 CFR 261 and consists of four lists as follows:

- Hazardous waste from non-specific sources (F-list);
- Hazardous waste from specific sources (K-list); and
- Commercial chemical products (P and U-lists).

The four lists of Listed Waste are attached to this training session as a reference source. As an example, the first three F-listed wastes are shown below.

Industry and EPA hazardous waste No.	Hazardous waste
F001	The following spent halogenated solvents used in degreasing: Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures
F002	The following spent halogenated solvents: Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2-trichloroethane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004, or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures
F003	The following spent non-halogenated solvents: Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, before use, only the above spent non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and, a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures

Each listed waste is given a four-place alpha-numeric designation. This is called the hazardous waste number or just the waste number. This designation is used to identify specific waste streams for purpose of disposal.

F-listed wastes are process specific and are applicable to all business and/or industry that perform or conduct the process that generates the waste. K-listed wastes are industry specific. They only apply to the type of industry described in the list. P- and U-listed wastes are specific to commercial chemical products. The relationship between the F- and K-listed wastes and the P- and U-listed waste is the difference between “used as intended” and “unused or used in a manner unintended.” For example, spent trichloroethylene used

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in degreasing operations is a F001 waste. However, a can of unused trichloroethylene that is disposed of as a waste will be listed as U228. The same would be true if the trichloroethylene were spilled and cleaned up using absorbent material. The waste generated from the clean-up would be listed as U228, not F001. In the first example, the trichloroethylene was unused, and in the second example, it was used in a manner not intended.

Characteristic Wastes - If a waste is not a listed waste, it may still exhibit hazardous characteristics. The four hazardous characteristics of concern are ignitability, corrosivity, reactivity and toxicity.

Ignitability - A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:

- (1) It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume, and has a flash point of less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester, using the test method specified in ASTM Standard D-93-79 or D-93-80 (incorporated by reference, see §260.11), or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D-3278-78 (incorporated by reference, see §260.11), or as determined by an equivalent test method approved by the Administrator under procedures set forth in §§260.20 and 260.21.
- (2) It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes, and when ignited, burns so vigorously and persistently that it creates a hazard.
- (3) It is an ignitable compressed gas as defined in 49 CFR 173.300, and as determined by the test methods described in that regulation, or equivalent test methods approved by the Administrator under §§260.20 and 260.21.
- (4) It is an oxidizer as defined in 49 CFR 173.151.

A solid waste that exhibits the characteristic of ignitability has the EPA Hazardous Waste Number of D001.

Corrosivity - A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:

- (1) It is aqueous and has a pH less than or equal to 2, or greater than or equal to 12.5, as determined by a pH meter using Method 9040 in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846, as incorporated by reference in §260.11 of this chapter.
- (2) It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F) as determined by the test method specified in NACE (National Association of Corrosion Engineers) Standard TM-01-69 as standardized in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846, as incorporated by reference in §260.11 of this chapter.

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A solid waste that exhibits the characteristic of corrosivity has the EPA Hazardous Waste Number of D002.

Reactivity - A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has *any* of the following properties:

- (1) It is normally unstable and readily undergoes violent change without detonating.
- (2) It reacts violently with water.
- (3) It forms potentially explosive mixtures with water.
- (4) When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
- (5) It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
- (6) It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
- (7) It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
- (8) It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR 173.53, or a Class B explosive as defined in 49 CFR 173.88.

A solid waste that exhibits the characteristic of reactivity has the EPA Hazardous Waste Number of D003.

Toxicity - A solid waste exhibits the characteristic of toxicity if, using the Toxicity Characteristic Leaching Procedure, test Method 1311 in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846, as incorporated by reference in §260.11 of this chapter, the extract from a representative sample of the waste contains any of the contaminants listed in Table 1 at the concentration equal to or greater than the respective value given in that table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering using the methodology outlined in Method 1311, is considered to be the extract for the purpose of this section.

TABLE 1-MAXIMUM CONCENTRATION OF CONTAMINANTS FOR THE TOXICITY CHARACTERISTIC

EPA HW NO.	CONTAMINANT	CAS NO.	REGULATORY LEVEL (MG/L)
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D018	Benzene	71-43-2	0.5
D006	Cadmium	7440-43-9	1.0
D019	Carbon tetrachloride	56-23-5	0.5

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D020	Chlordane	57-74-9	0.03
D021	Chlorobenzene	108-90-7	100.0
D022	Chloroform	67-66-3	6.0
D007	Chromium	7440-47-3	5.0
D023	o-Cresol	95-48-7	200.0
D024	m-Cresol	108-39-4	200.0
D025	p-Cresol	106-44-5	200.0
D026	Cresol	-	200.0
D016	2,4-D	94-75-7	10.0
D027	1,4-Dichlorobenzene	106-46-7	7.5
D028	1,2-Dichloroethane	107-06-2	0.5
D029	1,1-Dichloroethylene	75-35-4	0.7
D030	2,4-Dinitrotoluene	121-14-2	0.13
D012	Endrin	72-20-8	0.02
D031	Heptachlor (and its epoxide)	76-44-8	0.008
D032	Hexachlorobenzene	118-74-1	0.13
D033	Hexachlorobutadiene	87-68-3	0.5
D034	Hexachloroethane	67-72-1	3.0
D008	Lead	7439-92-1	5.0
D013	Lindane	58-89-9	0.4
D009	Mercury	7439-97-6	0.2
D014	Methoxychlor	72-43-5	10.0
D035	Methyl ethyl ketone	78-93-3	200.0
D036	Nitrobenzene	98-95-3	2.0
D037	Pentachlorophenol	87-86-5	100.0
D038	Pyridine	110-86-1	5.0
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D039	Tetrachloroethylene	127-18-4	0.7
D015	Toxaphene	8001-35-2	0.5
D040	Trichloroethylene	79-01-6	0.5
D041	2,4,5-Trichlorophenol	95-95-4	400.0
D042	2,4,6-Trichlorophenol	88-06-2	2.0
D017	2,4,5-TP (Silvex)	93-72-1	1.0
D043	Vinyl chloride	75-01-4	0.2

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A solid waste that exhibits the characteristic of toxicity has the EPA Hazardous Waste Number specified in Table I which corresponds to the toxic contaminant causing it to be hazardous.

Hazardous characteristics can be determined from either testing by a qualified laboratory, or presumed, based on the competent knowledge of the materials and processes that resulted in the generation of the waste. For example, if you know a coating is flammable before it is applied, any unused residue of that coating could be presumed to have the characteristics of ignitability. As a matter of practicality, all waste streams (unless obviously non-hazardous) should be assumed to be hazardous unless the appropriate testing demonstrates the waste is consistently non-hazardous. Even under these circumstances, you must be aware that material and/or process changes may result in a non-hazardous waste becoming hazardous, and vice versa.

Title:

Sampling and Analysis of Hazardous Waste

Objective of this Training Session:

To provide an overview of hazardous waste sampling and analysis procedures for hazardous waste handlers.

Introduction: The determination if a waste has hazardous characteristics, and is therefore a hazardous waste often involves sampling the waste stream and having it analyzed by a testing laboratory. It is important for the hazardous waste handler, who may be called upon to take samples and submit them for testing, to understand some basic elements of sampling procedures and testing. There are significant ramifications to improper sampling or poorly performed testing. These include:

- Misidentifying hazardous waste as non-hazardous, resulting in improper handling and/or disposal, which has the potential to result in violations, fines, environmental damage and/or injury to people.
- Misidentifying non-hazardous waste as hazardous, resulting in increased handling and disposal costs that would not normally be required.

Neither of these results can be tolerated. By understanding the proper procedures and consistently following the correct protocol, the hazardous waste handler can be more confident of his/her analytical results.

Sampling: Sampling is the physical act of removing a portion of a waste or material and providing the sample to a testing facility for analysis. If the sample is not procured in such a manner that is representative of the waste stream, the analytical results will be at best misleading and/or inaccurate (and therefore a waste of money), or at worst, will provide erroneous results that are used to make important handling and disposal decisions. Hazardous waste handlers must understand the quality of the analytical results provided the laboratory are only as good as the quality of the sample.

Quality Control - Quality is defined as the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs or standards. Quality Control is defined as a system of operational means for the fulfillment of quality standard requirements. The use of quality control results in a quality sample and/or analysis. Quality Assurance is a system for monitoring the fulfillment of quality requirements, and communicating the fulfillment both internally and externally. Quality Assurance is a check on the appropriateness (function and frequency) of Quality Control measures in the field and/or laboratory.

These elements of quality are important in both the taking of samples to be analyzed and the analysis itself. The results derived from the analysis must be as accurate a representation of the actual waste stream as possible. This is achieved by establishing a quality control program, with appropriate procedures to be consistently followed, and

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monitoring the program to determine if quality results are being achieved. For example, a quality control program for sampling an aqueous waste to determine the concentration of metals could include:

- Removal of the sample aliquot from a location in the waste stream that is representative of the entire waste stream.
- Always removing the sample from the same location.
- Determining the proper sample removal tools and storage containers that prevent contamination of the sample.
- The sample is of an adequate volume to allow the laboratory to conduct all necessary analysis.
- Ensuring that the sample removal equipment and storage containers have been properly cleaned and stored prior to use such that they have not become contaminated.
- Determining the proper environmental conditions for storage and transportation of the sample, such that the sample does not degrade prior to analysis.
- Establishing a sample labeling and identification protocol that prevents misidentification of samples.
- Following a strict chain of custody protocol to ensure integrity of the sample from the time it is removed to the time it is analyzed.
- Establishing a recordkeeping protocol which retains all necessary documents and data necessary to validate the waste determination which was made by using the analytical results.

The type of waste that is being sampled, in addition to other factors, (i.e., such as if the waste is being generated in batches or in a continuous process flow), will influence where elements of a quality control program are necessary and important. Always consult with the laboratory designated to perform the analysis prior to sampling a new (or modified) waste material. All qualified labs should be able to give you specific instructions on sampling protocol based on the tests that will be performed in the lab.

After establishing a sampling protocol for either a specific or generic waste stream, the protocol must be documented in a written format. When a sample is taken, reference to the sampling protocol should be made as a record of how the sample was taken. Deviations to the protocol, where unavoidable for a particular sample, should also be documented. This will help determine if unusual or anomalous analytical results may be explained by a change in how the sample was taken.

Sampling Safety - When sampling a known, or potentially hazardous waste stream, the safety of the personnel performing the sampling must be considered. This is particularly true when sampling a true “unknown” waste, where a reasonable hazard assessment

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cannot be conducted prior to sampling. All sampling activities must be conducted using proper engineering controls and/or personal protective clothing and equipment that are adequate to protect the person from contact and/or exposure to chemical hazards. Be aware that the sampling activity itself may introduce hazards that would not normally be present, such as venting of vapors when a drum is opened, or the splashing of hazardous chemicals back on the body when a sample cup is inserted into a flowing waste stream. When sampling an unknown waste, it is prudent to take extraordinary precautions, such as supplied air respiratory protection and multiple layers of gloves.

Analysis: Analysis is the procedure, methodologies and equipment used to determine the presence of a particular substance or compound, and to determine the level of its concentration in the sample. There are many different types of physical and chemical analysis in use for testing of waste constituents and characteristics. Many commonly used methodologies have been approved by the EPA for use in waste determinations.

The EPA publishes a manual of solid waste testing methodologies entitled “Test Methods for Evaluating Solid Waste,” usually referred to as SW-846. In its introduction, SW-846 states that it is:

“. . . intended to provide a unified, up-to-date source of information on sampling and analysis related to compliance with RCRA regulations. It brings together into one reference all sampling and testing methodology approved by the Office of Solid Waste for use in implementing the RCRA regulatory program. The manual provides methodology for collecting and testing representative samples of waste and other materials to be monitored. Aspects of sampling and testing covered in SW-846 include quality control, sampling plan development and implementation, analysis of inorganic and organic constituents, the estimation of intrinsic physical properties, and the appraisal of waste characteristics.”

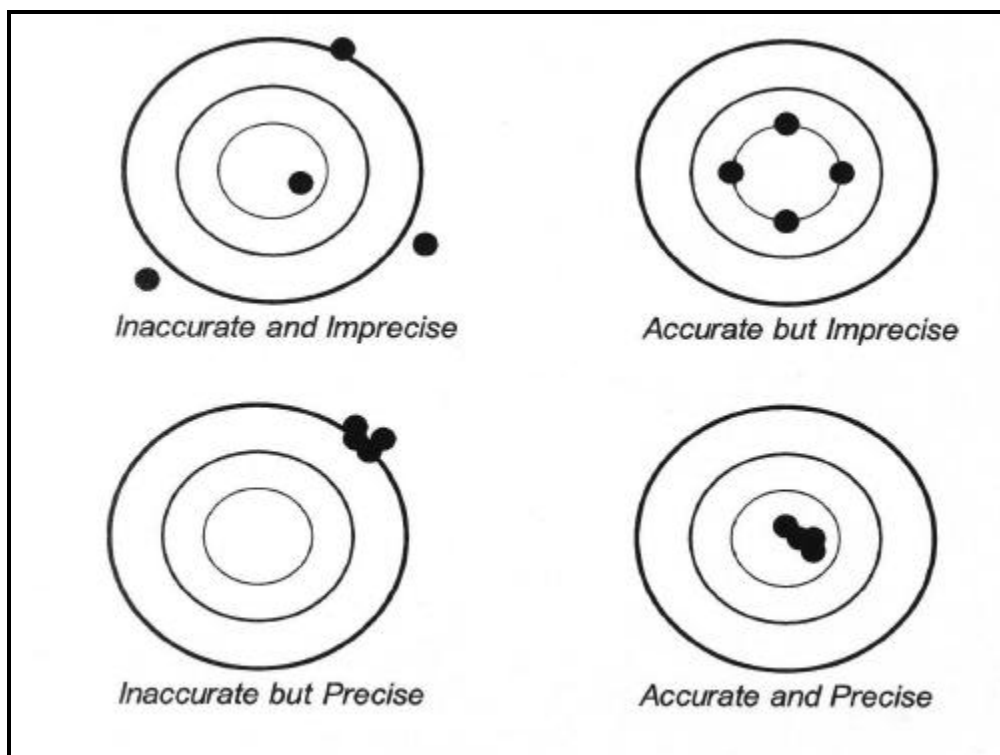
Most waste samples will be analyzed using approved methodologies described in SW-846. Additionally, some states have established different hazardous waste determination standards, and there may be different testing procedures that must be performed in these instances.

Data Quality Objectives - It is important to understand what is the quality objective of the data required from a waste analysis. The two most common data quality objectives (and most often misunderstood) are precision and accuracy. Both are representations of the quality of analytical data that provide useful information for the laboratory and the data user.

Precision is defined as the measure of mutual agreement between individual analytical results from replicates of the same sample.

Accuracy is the degree of agreement of an analytical measurement with an accepted reference value.

The difference between precision and accuracy is best illustrated graphically, as shown below:



As you can see from the graphic representations above, the data quality objective is dependent on both the accuracy and precision of the analytical results. Almost all methods have established precision and accuracy standards that must be met by the laboratory for the analysis to be considered valid.

Quality Control in the laboratory is done through a variety of means and techniques. As the end user of the analytical data, the most common elements of laboratory quality control that are seen are:

- Blanks - used to assess the presence or absence of analytical target constituents or interference in the analytical process;
- Spikes (often called “fortified samples”) - addition of a known amount of target analyte to the sample;
- Duplicates (lab analytical replicates) - a replicate aliquot of a real sample; and
- Surrogates - a compound that is similar in analytical behavior to the target analyte.

The Quality Control data supplied by the laboratory in conjunction with a specific analysis should be examined carefully to determine if acceptable standards are being met.

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Hazardous Waste Characteristics - The EPA has established specific tests to determine if a solid waste exhibits hazardous characteristics. These tests determine if a solid waste falls into one of the characteristic hazard categories: toxic, ignitable, reactive or corrosive. The hazardous waste handler needs to understand the basic elements of these tests to ensure waste samples are analyzed correctly.

Toxic - The toxicity of a sample is determined using the Toxicity Characteristic Leaching Procedure ("TCLP"). This test (SW-846 Method 1311) was devised to simulate landfill conditions. Here, the primary concern is with any waste that could potentially contaminate the groundwater. The general procedure is to remove the solids from a sample, mix the solids with a buffer solution for 18 hours, filter the resulting slurry, and then analyze the liquid portion for certain listed constituents. If the concentration of any listed constituent is equal to or greater than the established threshold concentration, the test would indicate the waste as a hazardous waste.

Ignitability - A solid waste exhibits the characteristics of ignitability if the flashpoint is less than 60° C (140° F). The EPA procedure for ignitability is SW-846 Method 1010. This method applies only to liquids; there is no established procedure by the EPA for soils or solids. The test is performed by loading the sample into a closed-cup Pensky-Marten flashpoint tester. The sample is heated and stirred. A flame is periodically introduced into the headspace area of the sample and the observed temperature at which the vapors ignite is recorded.

Reactivity - There is no single methodology for testing for reactivity. This is due to the fact that the regulation definition of reactivity includes several separate elements, as follows: (1) readily undergo violent chemical change; (2) react violently or form potentially explosive mixtures with water; (3) generate toxic fumes when mixed with water, or, in the case of cyanide- or sulfide-bearing wastes, when exposed to mild acidic or basic conditions; (4) explode when subjected to a strong initiating force; (5) explode at normal temperatures and pressures; or (6) fit within the Department of Transportation's forbidden explosives, Class A explosives, or Class B explosives classifications. This definition is intended to identify wastes, which as a result of their extreme instability and tendency to react violently or explode, pose a problem at all stages of the waste management process.

The EPA has established some procedures for testing to determine if a waste is reactive. These methods are found in SW-846 Chapter 7.3.

Corrosivity - Corrosivity is the capacity of a waste or material to corrode steel or human tissue. Tests for corrosivity as pH are SW-846 Methods 9040 and 9045. These involve the use of a pH meter to determine the pH of the sample. A pH measurement of equal to or less than 2, or equal to or greater than 12.5, indicates that the sample exhibits the characteristic of corrosivity.

Corrosivity to steel is SW-846 Method 1110.

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Title:

On-Site Storage of Hazardous Waste

Objective of this Training Session:

To understand the regulatory requirements for storage of hazardous waste on-site.

Introduction: Large quantity generators are allowed to store hazardous waste on-site at their facility for a maximum period of 90 days without having to be a permit Treatment, Storage and Disposal Facility. While the waste is stored on-site, the facility must comply with the regulatory requirements for on-site storage. The starting point for on-site storage requirements of hazardous waste is 40 CFR Part 262.34 - Accumulation Time. This section of the federal hazardous waste regulations provides that large quantity generators may store hazardous waste on-site for a period not to exceed 90 days, without permit, if certain conditions are met. These conditions include:

- Requirements for storage in containers and tanks;
- Marking of storage containers and tanks;
- Hazardous Waste Storage Areas;
- Requirements for satellite accumulation of hazardous waste; and
- The requirement to comply with subparts C (Preparedness and Prevention) and D (Contingency Plan and Emergency Response) of 40 CFR Part 265.

Each of these sets of requirements will be presented in detail in the following training session.

Storage in Containers and Tanks: Hazardous waste must be stored in containers (usually 55 gallon drums) and/or tanks while on-site. *(Note: There are provisions in the regulations to store hazardous waste in containment buildings and in waste piles. Most industrial facilities will not use these storage options. Therefore, these options are not covered here.)* Each of these storage options has specific requirements.

Containers - A container is defined as any portable device used to store hazardous waste. The specific requirements for on-site storage of hazardous waste in containers are:

- Labeling - Containers must be labeled. Container labels must be placed on the side of each container, and the labels must be clearly visible for inspection. The labels must contain at least the following information:
 - ◇ The words "Hazardous Waste"
 - ◇ The name and address of the generator
 - ◇ The accumulation start date.

Note: Many state regulations require additional information on labels.

- Container condition. Containers must be:

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- ◇ In good condition
 - ◇ Compatible with wastes stored in them
 - ◇ Kept closed at all times except when wastes are being added to or removed from the container
 - ◇ Handled in ways to prevent rupture or leaks.
- Container storage. Adequate aisle space between containers of hazardous wastes must be provided. "Adequate" refers to the national fire protection (NFPA) standards, which are generally 25 inches. State requirements regarding aisle space vary from 24 to 36 inches.
 - Ignitable, reactive, and incompatible wastes. Containers of ignitable, reactive, or incompatible wastes must not be mixed. Such wastes must be protected from ignition sources and stored in areas with "No Smoking" signs posted. (Note: Even if a facility is designated smoke-free, "No Smoking" signs must be posted.)
 - Ignitable and reactive wastes must be kept at least 50 feet from the property line.
 - Incompatible wastes must be separated from one another by physical barriers (e.g., berms, dikes, walls) or great physical distance.

Tanks - Tank means a stationary device, designed to contain an accumulation of hazardous waste which is constructed primarily of non-earthen materials (e.g., wood, concrete, steel, plastic) which provide structural support. The specific requirements for on-site storage of hazardous waste in tanks are:

- Label each tank with the words "HAZARDOUS WASTE."
- Store only waste that will not cause the tank or the inner liner of the tank to rupture, leak, corrode, or fail.
- Equip tanks that have an automatic waste feed with a waste feed cutoff system, or a bypass system for use in the event of a leak or overflow.
- Inspect discharge control and monitoring equipment and the level of waste in uncovered tanks at least once each operating day. Inspect the tanks and surrounding areas for leaks or other problems (such as corrosion) at least weekly.
- Use the National Fire Protection Associations (NFPA's) buffer zone requirements for covered tanks containing ignitable or reactive wastes. These requirements specify distances considered to be safe buffer zones for various ignitable or reactive wastes.
- Do not mix incompatible wastes or materials unless precautions are taken to prevent certain hazards.
- Do not place ignitable or reactive wastes in tanks unless certain precautions are taken.

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- Provide at least two feet (60 centimeters) of freeboard (space at the top of each tank) in uncovered tanks, unless the tank is equipped with a containment structure, a drainage control system, or a standby tank with adequate capacity.

Hazardous Waste Storage Areas: A Hazardous Waste Storage Area (“HWSA”) is any area within the facility where hazardous waste is stored until it is shipped to a Treatment, Storage and Disposal Facility (“TSDF”). The regulatory requirements for a HWSA are dependent on the types of management units (i.e., containers, tanks, waste piles, etc.) used at the HWSA and the type of wastes stored there (i.e., ignitable, reactive, etc.). While there is no specific regulatory requirement for a facility to have a hazardous waste storage area, any area used for the storage of hazardous waste becomes a defacto HWSA. For this reason, it is only prudent from a business management standpoint to designate a central storage area for hazardous waste, and ensure that the area meets all relevant requirements for the types of waste and management units required. This will consolidate all the storage requirements at one location (or perhaps more for a large facility), and will reduce the management, equipment and material burden necessary to properly and legally manage hazardous waste on-site.

Additionally, federal regulations specifically allow for the storage of small quantities of hazardous waste at their point of generation. These are termed Satellite Accumulation Areas and have some specific requirements of their own that are different than central storage area requirements. Both types of storage areas will be discussed in detail below.

Central Storage Areas: A central storage area for hazardous waste should have the following elements:

- Security - Restricted area access using wall or fence. Limit personnel access to hazardous waste handlers and other with proper business at the location. If not actually manned, the area should be secured and locked.
- Marking - Mark the area with a sign(s) stating: ***Hazardous Waste Storage Area and Danger! - Unauthorized Personnel Keep Out.***
- Lighting - Lighting within the storage area should meet the general requirements for good occupational health and safety. Additionally, there must be sufficient lighting to allow for inspection of containers and immediate detection of spills and/or leaks.
- Containment - A base which is free of cracks or gaps and is sufficiently impervious to contain leaks, spills, and accumulated precipitation until the collected material is detected and removed. The base should be sloped, or the containment system must be otherwise designed to drain and remove liquids resulting from leaks, spills, or precipitation. Alternatively, the containers may be elevated or otherwise protected from contact with accumulated liquids. The containment system should have sufficient capacity to contain 10% of the volume of containers or the volume of the largest container, whichever is greater.
- Spill Response - The area should maintain a adequate supply of spill clean-up equipment and supplies appropriate for the type and volume of wastes being stored.

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- Grounding - Grounding straps should be provided and used for containers of ignitable wastes.
- Storage Compatibility - The storage area should provide for the safe storage of incompatible wastes. This can be accomplished through the use of spacing, barrier walls, and the use of separate secondary containment structures.
- Communications - The storage area must have a communications system capable of making appropriate notifications in the event of an emergency, such as a fire or explosion.

Satellite Accumulation Areas: Federal regulations allow accumulation of hazardous waste at, or very near, its point of generation at the facility. This type of storage area can be very useful for those waste streams which are generated in only small amounts over longer periods of time. The requirements for Satellite Accumulation in facilities that are Large Quantity Generators of hazardous waste include:

- The area in which containers of hazardous waste are stored must be under the control of the operator of the process generating the waste.
- A maximum of 55 gallons of hazardous waste, or 1 quart of acutely hazardous waste, may be stored in containers in the satellite accumulation area.
- Any container in the area holding waste in excess of the volume limits as stated above must be marked with the words "Hazardous Waste," and the date on which the excess accumulation began.
- At any time that a container in the area is in excess of the volume limits, it must be removed to the central storage area within three days. During any three day period after excess hazardous waste has been accumulated, and before it is transported to the central storage area, the generator must comply with the container management requirements in 40 CFR 265.171 , 265.172 and 265.173(a).

Preparedness and Prevention: All Large Quantity Generators of hazardous waste must comply with the Preparedness and Prevention requirements for owners and operators of hazardous waste treatment, storage and disposal facilities as contained in 40 CFR Part 265 subpart C. This subpart includes specific requirements for hazardous waste storage areas, including:

- Equipment for internal communications for emergency notification and instructions, external communication equipment to notify and request assistance from off-site emergency responders, fire suppression and spill control and clean-up equipment, and water to supply water hose systems.
- All facility communications or alarm systems, fire protection equipment, spill control equipment, and decontamination equipment, where required, must be tested and maintained as necessary to assure its proper operation in time of emergency.
- Whenever hazardous waste is being physically managed (poured, spread, pumped, transferred, etc.), all personnel involved in the operation must have immediate access to an internal alarm or emergency communication device. If even just one employee is

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on the premises while the facility is operating, that person must have immediate access to a communication device capable of summoning external emergency assistance.

- The facility must maintain aisle space to allow unobstructed movement of personnel, fire protection equipment, spill control equipment and decontamination equipment to any area of the facility operation in an emergency.
- The facility must attempt to make arrangements with local and state emergency response organizations (police, fire and emergency response teams) as appropriate for the type(s) of hazardous waste handled, and to familiarize them as to the facility layout and operations. Where state or local authorities decline to enter into such arrangements, the facility must document the refusal in its operating record.

Contingency Plan and Emergency Procedures: All Large Quantity Generators of hazardous waste must comply with the Contingency Plan and Emergency Procedures requirements for owners and operators of hazardous waste treatment, storage and disposal facilities as contained in 40 CFR Part 265 subpart D. This subpart includes specific requirements for hazardous waste storage areas, including:

- The requirement for each facility to have a contingency plan that is designed to minimize hazards to human health or the environment from fires, explosions or any unplanned sudden or non-sudden releases of hazardous wastes to air, soil or surface water. The provisions of the plan must be carried out whenever there is a threat to human or environmental health caused by a fire, explosion or release.
- The requirement for the content of the plan to describe the actions that facility personnel must take in response to fires, explosions or releases of hazardous waste. The plan must also contain a description of arrangements agreed to by local and state emergency response organizations, the identification of the facility emergency coordinators, their office and home phone numbers, and an up-to-date list of all emergency equipment at the facility. Finally, the plan must include an evacuation plan for facility personnel in the event an evacuation is necessary.
- Copies of the contingency plan, and all revisions, must be kept at the facility and submitted to all local emergency response organizations that may be called upon to provide emergency services.
- The contingency plan must be reviewed and amended based on changes to applicable regulations, facility design, construction or operation, changes in emergency coordinators and/or changes in emergency equipment.
- The requirement that there must be at least one employee on-site or on-call at all times, with the responsibility for coordinating emergency response measures.
- The requirement that whenever there is an imminent or actual emergency situation, the emergency coordinator must activate the facility alarm or communication system, and notify state or local agencies with designated response roles if their help is needed. Additionally, the emergency coordinator must make determinations and assessments regarding the nature of the emergency and its potential impact on and off-site of the

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facility. During the emergency, the coordinator must take all reasonable measures to ensure fires, explosions and releases do not occur, or recur or spread. Following the emergency, the coordinator must provide for treatment, storage or disposal of recovered waste, and any waste generated as a result of the emergency. Finally, the affected area of the facility must be cleaned up and decontaminated prior to resumption of operations.

Conclusions: The requirements for on-site storage of hazardous waste are contained in several areas of the federal hazardous waste regulations. Additionally, the requirements can vary depending on the type and volume of the hazardous material being stored. While this initially can be confusing, the facility will develop standards and practices for waste management that implement the requirements consistently. Once a facility's waste streams are fully characterized, the requirements of on-site storage can be determined and their implementation will become routine.

Hazardous Waste Operator Training For Shipyard Personnel

Title:

Shipping Hazardous Waste

Objective of this Training Session:

To understand the proper procedure that must be followed when preparing for and shipping hazardous waste.

Introduction: When hazardous waste is offered for, and shipped to, a Treatment, Storage and Disposal Facility (“TSDF”), it must be prepared and manifested in accordance with EPA and DOT requirements. Requirements include:

- Proper packaging;
- Labeling and marking of shipping containers;
- Preparation of shipping documents; and
- Placarding of transport vehicles.

Hazardous waste handlers must be able to correctly and confidently perform these procedures, and ensure that these operations have been done correctly, if performed by others. This training session provides the basic information to perform these functions.

Packaging of Hazardous Waste for Shipping: The packaging of hazardous waste for shipment is subject to the same requirements as packaging of hazardous materials for shipment. The applicable requirements are found in 49 CFR parts 173, 178 and 179. The specific packaging requirements of waste material are identified in 49 CFR Part 172 subpart B - Table of Hazardous Materials and Special Provisions. This table should be used as a reference to determine the minimum required packaging requirements for the particular waste material being shipped. (In addition to packaging requirements, this table is used to determine other required shipping information as well.)

With regard to packaging information, the Table of Hazardous Materials is used in the following manner:

- Identify the waste material to be shipped in Column 2 of the Table;
- Use column 5 of the Hazardous Materials Table to determine the packaging group for the material;
- Check column 8a of the Hazardous Materials Table to see if any packaging exemptions exist, and check the listed reference to see if exemptions are applicable to the specific shipment;
- Check column 7 of the Hazardous Materials Table to see if any special provisions apply. The codes provided are explained in detail in section 172.102;
- Check column 8b for non-bulk packaging requirements or column 8c for bulk packaging requirements, as applicable. Check the listed reference for authorized packaging.

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For example, when using this procedure for a shipment of 55 gallons of waste acetone, we would determine that acetone is in Packaging Group II; that a packaging exception at CFR 49 173.305 is applicable for acetone (*173.150 Exceptions for Class 3 (flammable) and combustible liquids*), but not applicable for this shipment because the volume is greater than the allowable amount for the exemption, that there is a special provision (T8) for acetone which is not applicable to this shipment, and that non-bulk packaging requirements are provided at CFR 49 173.202. For this specific shipment, the following combinations of packagings are authorized:

Outer packagings:

- Steel drum: 1A1 or 1A2
- Aluminum drum: 1B1 or 1B2
- Metal drum other than steel or aluminum: 1N1 or 1N2
- Plywood drum: 1D
- Fiber drum: 1G
- Plastic drum: 1H1 or 1H2
- Wooden barrel: 2C2
- Steel jerrican: 3A1 or 3A2
- Plastic jerrican: 3H1 or 3H2
- Steel box: 4A
- Aluminum box: 4A
- Natural wood box: 4C1 or 4C2
- Plywood box: 4D
- Reconstituted wood box: 4F
- Fiberboard box: 4G
- Expanded plastic box: 4H1
- Solid plastic box: 4H2

Inner packagings:

- Glass or earthenware receptacles
- Plastic receptacles
- Metal receptacles
- Glass ampoules

Note that you can also upgrade your selection of packaging for a hazardous waste or material. For example, all hazardous waste could be shipped in 1A1 or 1B1 steel drums except for strong mineral acids, which should be shipped in 1A1 plastic drums. The drums meet the packaging requirements for all Packing Group I materials and may be used for Packing Group II and III materials as well. This ensures that the packaging requirements for all shipments of hazardous waste will be in compliance with DOT regulations.

Labeling and Marking of Shipping Containers: The terms labeling and marking refer to the information required to be placed on a container when it is offered for shipment by the

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EPA and DOT. EPA requirements for hazardous waste incorporate DOT requirements for hazardous materials by reference.

EPA - The EPA requires that each container of hazardous waste being offered for shipment be labeled and marked:

- In accordance with 49 CFR 172 (i.e., DOT hazardous materials container labeling requirements).
- Each hazardous waste container of less than 110 gallons in volume must be marked as follows:

<p style="text-align: center;">HAZARDOUS WASTE</p> <p>Federal Law Prohibits Improper Disposal.</p> <p>If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.</p> <p>Generator name and address: _____</p> <p>Manifest document no. _____</p>

DOT - The DOT requires that non-bulk packagings of hazardous materials or waste being offered for shipment must be labeled to include:

- The proper shipping name and identification number; as determined from the Table of Hazardous Materials in 49 CFR 172.101. (The proper DOT shipping name for a hazardous waste is not required to include the word “waste” if the package bears the EPA marking prescribed in 40 CFR 262.32, as shown above.)
- The consignee’s or consignor’s name and address, except when the packaging is transported by highway only, and will not be transferred from one motor carrier to another; or shipped as part of a carload, truckload or freight container load which is shipped from one consignor to one consignee.
- If an Exemption packaging is used, the package must be marked with the “DOT-E” and the exemption number assigned.
- Labeled with the diamond shaped symbolic hazard class as required for the material in the Table of Hazardous Materials at 49 CFR 172.101. (This information is found in column 6 of the Table).

Preparation of Shipping Documents: The only acceptable shipping document for hazardous waste is the EPA universal hazardous waste manifest, or state equivalent. This document will also satisfy the DOT requirement for shipping papers for hazardous waste.

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The Manifest Form - The "Uniform Hazardous Waste Manifest" is the shipping document that travels with hazardous waste from the point of generation, through transportation, to the final treatment, storage, or disposal facility (TSDF). This one-page form (with multiple carbon copies attached) is at the heart of the EPA hazardous waste management system. Each party in the chain of shipping, including the generator, signs and keeps one of the manifest copies, creating a "cradle-to-grave" tracking of waste.

The directions for completing a manifest are pre-printed on the reverse of each original manifest. Most states use an eight-part manifest. The party to whom each of the eight copies goes is also pre-printed on each copy.

Each required item on the manifest form is numbered. The following information provides the specific requirements for each section of the form:

- Item 1—Generator's U.S. EPA ID Number and the Manifest Document Number. The generator's ID number is a 12-digit/letter combination. Make sure there are 12 spaces filled. The document number is a unique five-digit number assigned by the generator. All five spaces must be filled.
- Item 2—Page 1 of _____. Be sure a number is filled in here. If there is not a continuation sheet, you should fill in the number 1. Be sure to check your state manifest directions—many states do not allow the use of continuation sheets. If your State does not allow the use of continuation sheets, always fill in this block with the number 1.
- Item 3—Generator's Name and Mailing Address. This information should also be the location that will manage manifest copies once these copies are returned. Manifest copies may not be managed at another office (e.g., corporate headquarters). They must be kept at the generation address.
- Item 4—Generator's Phone Number. Enter the telephone number of an authorized person capable of answering questions if there is an emergency.
- Item 5—Transporter 1 Company Name. Enter the name of the transporter you use to transport your wastes. (Many generators do not need more than one.)
- Item 6—Transporter 1 EPA ID Number. Make sure 12 spaces are filled.
- Item 7—Transporter 2 Company Name. Enter the name of the second transporter if you are contracting a second. If none is expected, enter "none." If more than two transporters are to be used, a continuation sheet will be necessary to list the information applicable for Transporter 3.
- Item 8—EPA ID Number of Transporter 2. Enter the transporter's EPA ID number, making sure to fill in all 12 spaces.
- Item 9—Designated Facility Name and Site Address. Enter the name and location of the designated disposal site for wastes on this manifest. This must be the site address vs. a PO box or other mailing address.

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- Item 10—Designated Facility ID Number. Again, enter the 12 letter/digit combination.
- Item 11—U.S. DOT Description. In proper order, enter the DOT shipping name, hazard class, ID number, and packing group. Include hazardous substance information, technical wording, marine pollution information, poison wording, and other details required by 49 CFR 172 Subpart C—Shipping Papers.
- Item 12—Container Number and Type. Enter the number and type of container for each line item. Note that allowed abbreviations are specified on the back of each original manifest. The only container-type abbreviations that may be used are those listed.
- Item 13—Total Quantity. Quantity of waste listed in each line item. The appropriate abbreviation for kilograms on a hazardous waste manifest is "K."
- Item 14—Unit of Measure. As with Item 12, only abbreviations listed in the manifest instructions are allowed.
- Item 15—Special Instructions. This is one of only two places on the form wherein a generator may insert additional information or information that does not fit in other numbered blocks (i.e., Item 11). This space is frequently used to list any emergency response information that is applicable, 24-hour emergency response telephone numbers, or other pertinent details. If the density of the liquid being shipped is other than 1, this information must be entered in Item 15.
- Item 16—Generator's Certification. This is very important because this is where the generator assumes all the liability inherent in the hazardous waste management regulations. Additionally, by signing, a generator certifies that he or she is doing everything economically practicable to minimize the generation of hazardous waste at the facility.
- Item 17—Transporter 1. Signs to acknowledge receipt of materials.
- Item 18—Transporter 2. Signs to acknowledge receipt of materials.
- Item 19—TSDf Discrepancy Indication Space. This is where the TSDf notes any differences between what the manifest says will be received vs. what is actually received. For example, if you ship ten drums and only nine show up at the TSDf, that would be noted in Item 19. If the discrepancy cannot be resolved within 15 days of receipt of the waste, the TSDf must mail a copy of the manifest, a letter describing the discrepancy, and an outline of steps taken to resolve the discrepancy to the state in which it is authorized to operate.

Manifest Attachments - Other documents may be attached to a hazardous waste manifest, including:

- Land disposal restriction forms

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- Hazardous waste determinations
- Copies of analytical results
- Emergency response information

Copy Distribution - When the generator initiates a hazardous waste manifest, there may be as many as eight copies in the manifest package. Some copies of the manifest are left behind as each shipment proceeds from its point of generation to its ultimate destination. The copies are distributed as follows:

- Step 1—The generator completes the manifest. When Transporter 1 arrives and the waste is transferred to the transport vehicle, the generator retains copies 6, 7, and 8.
 - ◊ Copy 6 is mailed by the generator to the destination state.
 - ◊ Copy 7 is mailed to the generator state agency.
 - ◊ Copy 8 is retained at the generator facility for at least three years.

The transporter leaves the site with the wastes and copies 1 through 5 of the manifest.

- Step 2—The transporter arrives at the TSDf. The TSDf signs for receipt of the waste and takes copies 1 through 4. The transporter retains copy 5. The TSDf keeps copy 4 in its files for at least three years. The TSDf mails:
 - ◊ Copy 1 to the destination state agency
 - ◊ Copy 2 to the generator state
 - ◊ Copy 3 back to the generator.
- Step 3—Each recipient of a manifest copy is now capable of tracking waste from its point of generation to its point of disposal. If the destination state agency does not receive the second copy noting receipt at a disposal facility, the agency will follow up with the generator.

Exception Reports - If a generator does not receive a manifest copy from the TSDf within 35 days after Transporter 1 picks up a shipment, the generator must take steps to find the waste.

If the generator has not received a copy of the manifest within 45 days of initial pickup, an exception report must be filed with the state in which they operate or the EPA administrator in the region.

The exception report must include a copy of the manifest in question as well as a letter outlining the efforts the generator has made to find the waste.

Placarding of Hazardous Waste Transport Vehicles: The generator of a hazardous waste that is offering the waste for shipment must offer to provide appropriate placards for the transport vehicle. It would be unusual these days for a licensed hazardous waste transport company not to

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have and use their own placards during transportation. However, the requirement for the generator to offer the use of the placard remains. It is also important that the hazardous waste handler understand how the appropriate placard is selected in order to ensure that their transport has correctly placarded the vehicle before leaving the facility.

The Department of Transportation has established vehicle placarding requirements for hazardous material (and waste) shipments. In general, each bulk package, freight container, unit load device, transport vehicle, or rail car must be placarded on each side and end. Placarding requirements are summarized in two placarding tables located in the hazardous material regulations. These requirements depend on the hazard class and the quantity of the materials being shipped. The hazard class for a specific material is listed in column 3 of the Table of Hazardous Materials. Table 1 covers placarding for class 1.1, 1.2, 1.3, 2.3, 4.3, 6.1, and 7, while all other classes are covered in Table 2.

- Table 1 is used to determine the placarding requirements for any quantity of division 1.1, 1.2 or 1.3 explosive, poisonous gas, dangerous when wet material, and division 6.1 poison or radioactive material.
- Table 2 is used to determine the placarding requirements for all other classes of hazardous materials. Placards are only required for these materials if the aggregate gross weight exceeds 1,001 pounds.

Prior to using these tables, you must first identify the hazard class of the material using column 3 of the Table of Hazardous Materials.

- Depending on the hazard class of the material, select the applicable placarding table and determine the placarding requirement for that specific hazard.
- Consult the footnotes of the placarding tables to ensure that no other requirements or exemptions apply.

Subsidiary hazards - If a hazardous waste has subsidiary hazards as indicated below, additional placarding requirements will exist:

- Dangerous when wet: Materials which also meet the description of a DANGEROUS WHEN WET material must be placarded as such.
- Poisonous by inhalation: These materials must be placarded POISON or POISON GAS in addition to the standard placard requirement.
- Uranium Hexafluoride: This material must be placarded CORROSIVE, as well as RADIOACTIVE.

Exceptions to placarding requirements can also exist as follows:

- DANGEROUS Placard: A transport vehicle, unit load device, freight container or rail car containing two or more non-bulk packages of hazardous materials covered in Table 2 can be placarded in lieu of each separate placard. The DANGEROUS placard cannot be used on cargo tanks, portable tanks, or tank cars. If more than 5,000 pounds of a material is being transported its placard must be used.

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Conclusions: Preparing hazardous waste for shipment involves not only a knowledge of the waste material, but also EPA and DOT shipping requirements. While these requirements can sometimes be confusing, once determined for a particular waste stream, they will remain consistent for future shipment of this waste. Most shipyards will only ship a dozen or so wastes on a regular basis. Determine the shipping requirements for these wastes and document the requirements for future use. If the initial shipping requirements were determined correctly, you can be confident that compliance with the shipping regulations will be achieved.

Hazardous Waste Operator Training For Shipyard Personnel

Title:

Common Shipyard Hazardous Waste

Objective of this Training Session:

To provide an overview of the common types of hazardous waste generated from ship building and repair activities.

Introduction: All shipyards generate similar types of hazardous waste. Surface preparation and preservation, bilge and tank cleaning, lagging, pipefitting, and equipment repair are examples of the common operations and processes that can generate a hazardous waste. This training session identifies some of the common hazardous waste generated by shipyards, identifies the federal standard that may cause the waste to be classified as hazardous, and provides some comments on the identification and/or handling of the waste.

Common Shipyard Hazardous Wastes: The following table provides a summary of information regarding common shipyard hazardous waste. It is important to note that while this table can provide some information regarding each waste stream, hazardous waste determination are process and/or operation specific. For this reason the hazardous waste handler must ultimately rely on his knowledge of the materials and process that generated the waste, as well as testing, when making a definitive waste determination. You must also note that many states have additional hazardous waste requirements that must be followed.

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Common Shipyard Hazardous Wastes

Waste Stream	Possible Hazardous Constituents	Listed Waste	Characteristic Waste	Comments Regarding Hazardous Waste Handling in the Shipyard
Paints and Coatings, solvent based. Liquid and sludge.	Organic Solvents, Metals	F003 and/or F005 depending on which solvents are in the paint.	Ignitability - D001 Toxicity (metals) D004-D0043.	Different types of paints and coatings should not be commingled. In particular, do not commingle organic solvent based coatings with water based coatings. In many instances, this will prevent the water based coating from becoming a hazardous waste via the “mixture” rule. Opening the lids of containers containing organic solvent based coatings to allow evaporation of the solvents is a violation of the hazardous waste storage regulations, and should not be done. Organic solvent based coatings often have a high BTU content and can be recycled for their heat value by a fuel blender.
Paints and Coatings, solvent based. Solids.	Metals		Toxicity (metals) D004-D0043.	Solid paint waste containing metals may not be leachable via the TCLP test. This is often the case for plural component coatings such as epoxies. Be careful that no organic solvents remain in the paint.
Paints and Coatings, water based. Liquid or Solid.	Metals		Toxicity (metals) D004-D0043.	Some water based coatings may contain metals. Check the Material Safety Data Sheet to disposing water based coatings as non-hazardous.
Spent degreasing and spray gun cleaning solvent. Organic solvent	Organic solvents, halogenated solvents and/or metal contamination	F001, F002, F003, and/or F005 depending on which solvents are	Ignitability - D001 Toxicity (metals) D004-D0043.	Spent solvents are usually a good material to reclaim on-site and reuse. Off-site reclamation is also usually a good alternative to destructive treatment such as incineration. Be aware that all spent solvents will be burdened with

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based. Liquid.	from degreasing or gun cleaning operations.	used.		contaminates derived from the cleaning or degreasing operations, including oils, grease and possibly metals. These contaminants may result in spent solvent acquiring hazardous characteristics, such as toxicity.
Spent degreasing and spray gun cleaning solvent. Water based. Liquid.	Metal contamination from degreasing or gun cleaning operations.		Toxicity (metals) D004-D0043.	Be aware that all spent solvents will be burdened with contaminants derived from the cleaning or degreasing operations, including oils, grease and possibly metals. These contaminants may result in spent solvent acquiring hazardous characteristics, such as toxicity.
Bilge water, tanks cleaning - oily water separation, gravitational separation of non-emulsified oil.	Petroleum sludge, metals.	F037	Toxicity (metals) D004-D0043.	The sludge derived from passive (gravitational) oily water separation is a listed waste. Depending on other factors in the origin of the sludge, it may also have other contaminants such as metals.
Bilge water, tanks cleaning - oily water separation, physical or chemical separation of emulsified oil.	Petroleum sludge, metals.	F038	Toxicity (metals) D004-D0043.	The sludge derived from active (physical and/or chemical) oily water separation is a listed waste. Depending on other factors in the origin of the sludge, it may also have other contaminants such as metals.
Spent abrasive media.	Metals, derived from the media, coatings and/or substrate blasted.		Toxicity (metals) D004-D0043.	Lead is the most common metal of concern that has the potential to make spent abrasive a hazardous waste.
Baghouse dust	Metals, derived		Toxicity (metals)	Baghouse fines tend to have higher concentrations of

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from dry abrasive blasting operations.	from the media, coatings and/or substrate blasted.		D004-D0043.	metal contaminates than the spent abrasive they were derived from. Assume all baghouse fines are a hazardous waste unless there is definitive knowledge or testing which determines it is non-hazardous.
Caustic cleaners and degreasers solutions.	Sodium and/or potassium hydroxide, other caustic chemicals. Metal contamination from degreasing operations.		Corrosivity D002 Toxicity (metals) D004-D0043.	Caustic solutions can be tested easily on site to determine if they are a likely hazardous waste due to a high pH. If metal or other contamination from the cleaning operation is suspected, it is prudent to test the waste to ensure proper waste determination.
Acid Cleaners and Acid Etching solutions.	Hydrochloric, sulfuric, nitric, acetic and other acids. Metals derived from cleaning or etching operations.		Corrosivity D002 Toxicity (metals) D004-D0043.	Acid solutions can be tested easily on site to determine if they are a likely hazardous waste due to a low pH. If metal or other contamination from the cleaning or etching operation is suspected, it is prudent to test the waste to ensure a proper waste determination.

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Title:

Best Management Practices for Hazardous Waste Handlers.

Objective of this Training Session:

To provide an understanding of how hazardous handling, transporting and storage can result in pollutants being discharged to air, ground and water - and provide a practical set of Best Management Practices to eliminate or reduce this potential discharge.

Introduction: Best Management Practices (“BMP”) are engineering, process and operational controls that will help eliminate or reduce pollution. BMPs can involve materials used in processes, where, how and when a process is conducted, identifying and eliminating pollution pathways, material storage and many other elements of shipyard operations. This training session provides practical BMPs for the processes and operations associated with hazardous waste handling. The effectiveness of BMPs should be evaluated on a periodic basis to ensure the practices and procedures are effective.

Hazardous Waste Best Management Practices:

BMP #1 - MATERIALS COMPATIBILITY

Objective: To minimize spills and accidents associated with materials that are incompatible and can injure employees and pollute the environment.

BMP:

- Hazardous waste handlers should identify areas where waste compatibility problems may exist, and define procedures to prevent accidents.
- Evaluations on waste compatibility must be based on the following four factors:
 - 1) Compatibility of container waste with the container contents;
 - 2) Compatibility of waste mixed within the container;
 - 3) Compatibility of the waste with the environment; and
 - 4) Compatibility of waste with adjacent stored waste (i.e., wastes that are not compatible should not be stored next to one another).
- The following steps should be taken in order to minimize the impact should a spill occur:
 - 1) Store potential problem chemicals in containers of 55 gallons or less when possible;
 - 2) Prepare a response system and spill control measures (e.g., secondary containment, absorbent material, sand bags, empty drums, brooms, shovels, etc.); and

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- 3) If new procedures and processes are initiated, environmental and safety personnel should be notified, and the BMP should be changed accordingly.

BMP # 2 - PERMANENT & TEMPORARY STORAGE TANKS

Objective: Provide proper permanent and temporary waste storage tank facilities. The storage tank systems shall be designed with sufficient secondary containment capacities to ensure that spillage does not soak into the underlying soils or enter nearby surface waters.

BMP:

- Waste storage tanks must be surrounded by a curb, dike, berm or some other type of secondary containment system which provides sufficient area to help contain possible spills.
- All pumping, valves, metering and coupling equipment must be leaktight. Leaks must be immediately repaired when discovered.
- The containment systems shall be designed to be free of cracks and caps, and be sufficiently impervious to contain leaks and spills until they can be pumped and cleaned out.
- When a leak or spill is discovered, the containment system shall be immediately cleaned, the liquid shall be considered hazardous waste and managed in accordance with environmental regulations.
- Rainwater trapped inside the containment area needs an acceptable method of disposal which should be determined on a case-by-case basis.

BMP #3 - SECONDARY CONTAINMENT

Objective: To ensure that secondary containment systems are in place to catch accidental spills, leaks, and splashing of chemicals and wastes that could result in pollution.

BMP:

- When storing hazardous materials/wastes, special attention must be given to locations of storm drains and their distance to the surface waters.
- Don't allow rainwater to accumulate in the secondary container. Empty the containment as soon as possible.
- When cleaning parts and equipment, use secondary containment systems such as sand bags covered by plastic, drip pans or canvas tarps.
- Place drip pans under valve connections, and pump connections during waste transfer operations.

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- Provide separation between secondary containment systems that contain incompatible hazardous materials or wastes.

BMP #4 - HAZARDOUS MATERIALS & WASTES STORAGE AREAS

Objective: Provide storage areas for hazardous materials and hazardous wastes such as oils, paints, solvents, grit blast media and others in a location that reduces the probability that spillage does not enter pathways leading to surface waters. Major pathways to surface waters include storm drains, utility trenches, direct runoff channels, and unsealed manholes.

BMP:

- Hazardous material/waste storage areas must be adequately posted/placarded or otherwise made distinguishable in order to maximize visibility.
- Secondary containment systems shall be used when storing hazardous materials/wastes whenever applicable.
- Containers holding hazardous materials/wastes shall be in good condition with no visible signs of severe rust or with any apparent structural defects.
- If a container begins to leak, the contents of the container shall be transferred to a container in good condition.
- Hazardous materials/wastes that are incompatible shall not be stored next to one another, and if applicable, should have separate secondary containment systems.
- All containers must always be closed during storage, except when it is necessary to add or remove material/waste.
- All containers must be handled and/or stored in a safe manner so as to prevent ruptures to containers and prevent leaks.

BMP #5 - STORM DRAIN PROTECTION

Objective: To keep storm drains and their surrounding areas clean in order to prevent storm water from washing waste and other pollutants into surface waters.

BMP:

- Any and all storm drains within the hazardous waste handling and/or storage area(s) should be fitted with grate screens which help stop pollutants such as trash, and construction materials from entering into the storm drain system.
- All storm drains within the hazardous waste storage area shall be cleaned on a monthly preventative maintenance schedule.
- **NO DUMPING** - Do not utilize storm drains for disposal of paints, solvents, oils, trash, abrasive grit blast, debris, or any other hazardous waste or material. Illegal dumping to storm drains or surface waters is unacceptable and unlawful.

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- There should be no storage of hazardous wastes or hazardous material near any storm drain, unless the material or waste is held within secondary containment.
- Storm drain control valves should be installed on all storm drains where there is the potential for pollutants to enter the drain.
- If a spill of a hazardous pollutant occurs near a storm drain, immediately use absorbent material or pads to construct a curb or berm to prevent the pollutant from entering the drain.

BMP #6 - GOOD HOUSEKEEPING AND GENERAL WASTE YARD CLEAN-UP

Objective: To maintain a clean and well ordered working environment in the hazardous waste handling and storage areas.

BMP:

- All refuse including: paper, cans, bottles, wood, steel and other debris are to be removed and properly disposed.
- Any grit blast material is to be swept up and immediately placed in containers. Segregate grit blast from other wastes.
- The working area and aisles shall be kept "sweep clean" at all times, to prevent potential contaminated material from being blown or washed by rain from the area.

BMP #7 - LEAKING PIPES, HOSES AND VALVE CONNECTIONS

Objective: Prevent leakage of pollutants from hoses, valves and couplings from entering surface waters and storm drains.

BMP:

- Leakage from hose connections in the hazardous waste storage and/or handling areas are designated as unapproved discharges to surface waters.
- Leaks in hoses and fittings must be immediately repaired.
- Hose and pipe connection replacement items should be kept in stock.
- Inspections of hoses, piping connections, and valves shall be conducted on a regular basis.
- When breaking hose connections, a secondary containment system (drip pan, bucket, etc.) shall always be in place.

BMP #8 - HAZARDOUS WASTE TRANSFERS

Objective: To prevent the release or discharge of pollutants during the transfer of hazardous waste from one container to another.

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BMP:

- When possible, use transfer pumps and hoses rather than pouring waste from one container to another.
- Pumping rates should be slow enough to allow shut down of the pump prior to overfilling a container.
- Never leave the transfer operation unattended.
- Provide secondary containment at all potential leak or spill points in the transfer system.
- When pouring from one container to another, use funnels or other transfer devices to prevent spillage from “slop.”
- Ensure that the containers are correctly vented during transfer or pouring to prevent “burping” of the container contents.
- Immediately clean all residuals from the top or sides of containers after transfer operations are complete.

BMP #8 - HAZARDOUS WASTE TRANSPORT

Objective: To prevent the release or discharge of pollutants during hazardous waste transport operations.

BMP:

- Ensure all containers of hazardous waste are intact, and have proper lids and/or other seals prior to transporting.
- Properly secure the load prior to transport by forklift or truck.
- The spillage of any amount of hazardous waste during transport requires the area to be secured, and clean-up procedures to be initiated immediately. Never allow vehicles or personnel to “spread” spilled waste to other areas of the facility by tracking through an unsecured spill.
- The use of secondary containment pallets is strongly recommended when transporting containers of liquid wastes.
- Never transport drums or other containers with only the tines of the forklift. Always carry containers on a pallet or other authorized carrying device.

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